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STOCHASTIC SIMULATION OF LABOR DEMAND UNDER WAGE SUBSIDIZATION

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ABSTRACT

The impact of a system of wage subsidies, funded by unemployment insurance vouchers, is evaluated by combining a set of disaggregated industry labor demand models with an input/output model. The program is shown to increase employment initially by lowering the cost of labor to firms. The disposable income of workers is increased which acts as a macroeconomic stimulus. The success of the subsidy program depends to some extent on the degree to which demand induced by greater consumer spending is able to sustain higher employment levels. Overall, it is estimated that a four-quarter wage subsidy equivalent to 30 percent of prevailing industry wages results in a long run decline in unemployment in excess of 1 percent.

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1. Introduction

This report is an attempt to evaluate the potential effect of a program of wage subsidies. The Productive Employment Program (PEP) was proposed by Allen V. C. Davis as a more efficient way of allocating unemployment insurance (UI) resources to create new jobs and permanently lower unemployment. The PEP program was motivated by two fundamental insights into the current system of unemployment compensation. First, though UI benefits certainly help to cushion the blow of unemployment, the UI program does little or nothing to assist recipients in finding new employment. In fact, the program has been shown to have substantial work disincentive effects, since the favorable tax treatment afforded UI compensation coupled with the loss of benefits when the recipient is reemployed greatly reduce the benefits of employment. Second, unless it is made cost-effective for employers to hire the unemployed, the economy will not fully utilize the productive capacities of the labor force and output levels will be suboptimal. More specifically, given high reservation wages demanded by unemployed workers (to some extent induced by the system of unemployment insurance), firms will not find it profitable to expand their output beyond current levels. If wages for unemployed workers were subsidized, the firms' marginal costs of production would fall and, by standard microeconomic arguments, output would be increased.

In view of current budgetary constraints, no subsidy program requiring additional outlays is feasible at this time. The PEP program takes advantage of the fact that the federal government is already committed to funding unemployment insurance at a $25 to $30 billion annual rate. This is a substantial sum which could potentially be redirected toward providing employment opportunities, rather than unemployment compensation, for the unemployed. In addition, an increase in productive employment would have other benefits. An increase in employment means an increase in tax revenues and a decrease in welfare costs, which could assist current efforts to reduce the federal deficit. Moreover, turning idle workers into productive ones could increase aggregate output, making American industries more competitive in world markets and increasing national wealth.

The productive employment program is purposely very simple in its details. Unemployed workers would be offered a voucher which they would cash to receive their current benefits or could turn over to an employer. The employer would be allowed to collect 50% of the employee's UI benefit for a period up to twice the number of weeks of eligibility for UI benefits remaining to the employee. Paperwork and other bureaucratic burdens would be minimized and it could be left to the market to determine where workers would find employment. Any employment achieved under the program would be productive employment, thus avoiding the most serious criticism of many prior job creation programs.

Several attempts to evaluate the PEP program were made prior to the present study. One was based on altering the level of business profits in a large macroeconomic model to determine the effects on employment levels while another was based on simulations of a single sector equilibrium model for the supply and demand of labor. Neither of these efforts could answer what is fundamentally an empirical question: how would firms react to the availability of a wage subsidy? Also, these prior efforts at evaluation were necessarily somewhat restricted in their ability to model particular features of the PEP program which might be altered and, hence, affect the program's effectiveness.

The authors were faced with the task of constructing a model of firms' hiring behavior on an industry by industry basis. However, it was obvious from the onset that it would be necessary to incorporate macroeconomic effects on firm behavior that result from the program's stimulation of employment. In fact, it is crucial to the success of the PEP program that its stimulation of firm output levels lead to an overall increase in economic activity and aggregate demand. A temporary wage subsidy need not have any effect on long run employment levels. When a worker's subsidy expires, he or she will be laid off unless sufficient human capital has been accumulated in the course of employment to justify a higher wage or unless the exogenous demand for the industry's output has increased in the interim. A main portion of our task was to estimate the degree to which an initial expansion of the economy caused by the PEP program would be sufficient to sustain over the long run the employment of workers first hired on a subsidy.

The details of the model constructed for the PEP policy

analysis are summarized in the next section. Briefly, however, we can report our most important findings:

(1) A subsidy between 20% and 30% of prevailing industry wages increases the level of employment by almost 1.0%.

(2) Summed across industries, the program increases personal consumption (net of the implied decrease in transfer payments) by $5 to $10 billion per year. This increase in consumer spending is sufficient to provide permanent employment to most (more than 80%) of those hired because of the subsidy.

(3) The PEP program increases federal tax revenues by between $1.2 and $2.0 billion per year and, simultaneously, slows the depletion of the Unemployment Trust Fund.

(4) Although the efficacy of the program is reduced slightly in a recessionary environment, the PEP program still increases employment under these conditions and, hence, has a favorable countercyclical impact.

Altogether, our findings point to a positive assessment of the PEP program. The program is, of course, no panacea for all the economy's ills, but it does offer the possibility of permanently reducing unemployment--one of the economy's most enduring and least tractible maladies.

2. <u>Overview</u>

To analyze the effects of the PEP program we attempt to delineate the sectors of the macro economy directly involved. This itself is a task fraught with difficulty. A program such as PEP affects the decisions of individual firms and simultaneously affects their output and in general the entire macro economy. Is it then possible to choose a sub-sector of the economy for scrutiny which represents the salient features of PEP while capturing the inter-industry macro-economic effects?

Our approach focuses on the labor market. In the labor market, firms make hiring and firing decision based upon prevailing wages and the general state of the macro-economy. Individuals also make choices--how much to work, which jobs to take. The PEP program targets subsidies to firms in the wages they pay in order to stimulate the demand for labor. Therefore we choose to analyze the demand for labor and assume that, in the margin in which the PEP program operates, there are involuntary unemployed individuals who will accept jobs at the prevailing market wage.

Our analysis of the demand for labor recognizes that different industries are affected differently by the macro-economy, and that substitution of labor for capital depends crucially on the level of real production. It would not be appropriate, therefore, to use a single demand for labor equation for the economy. Furthermore, we recognize that the cost of capital for each industry varies, as well as the cost of labor. Therefore, we attempt to insure that our model

of labor demand by industry recognizes and adjusts to prevailing market conditions. To allow for the variability in demand across industries we employ an econometric analysis of the U.S. labor market. Each of 26 industries is given separate treatment and analyzed individually to insure that industry specific forecasts will be as accurate as possible.

If the PEP program were only to subsidize wages we would not expect long term impacts on the demand for labor. However, we do expect that short-run increases in demand will lead to longer run increases in output. In our model, the demand for labor is a function of output as well as wages. Hence, the PEP program influences the demand for labor directly through the wage and indirectly through the induced effects on output.

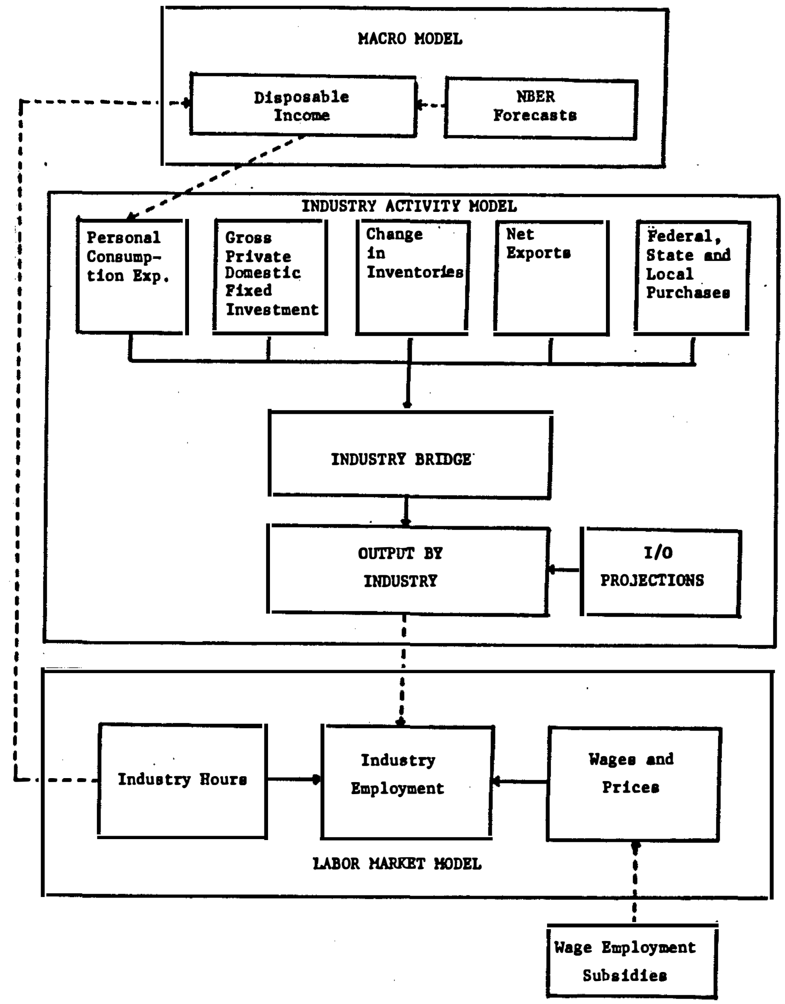
To model the important interindustry effects arising from increased aggregate demand we need a model of the macro-economy. Our approach has been to use input/output analysis to translate increases in aggregate demand into changes in industrial output levels. Input-output analysis explicity considers the flows of goods and services among industries and determines output levels by industry required to meet a given level of final demand. Rather than model aggregate demand for the economy (a task with complexity that necessitates a several thousand equation macro-econometric model), we use baseline macroeconomic forecasts from the American Statistical Association and the National Bureau of Economic Research. The effects of the PEP program are then determined relative to the baseline forecast.

Simulation of the PEP program requires linking several models together, explicity introducing the feedback from changes in disposable personal income to industry activities. The simulation algorithm is illustrated in Figure 1. The middle set of boxes represent the components of aggregate demand: personal consumption expenditure, domestic fixed investment, the change in business inventories, net exports and, federal and state and local purchases. Given levels of aggregate demand, an industry bridge determines the level of final demand for each industry. Output by industry is then determined using the input/output projections.

The lower set of boxes in Figure 1 illustrate the labor market model. Here output by industry and prevailing wages determine employment in each industry. The PEP program is modeled to directly affect wages in the labor market.

Finally, changes in disposable income above the baseline scenario are translated into changes in personal consumption expenditure (in the top set of boxes denoted as the macro model). The relationship between disposable personal income and personal consumption expenditure employs a consumption function.

FIGURE 1



3. Labor Market Model

Employer response to the availability of wage subsidies can be predicted using knowledge of firms' labor demand functions. A wage subsidy lowers the cost of labor relative to other factor inputs so that, for a given level of output, employers will substitute labor for other inputs into the production process. Precise evaluation of the effects of any subsidy policy depends, of course, on reliable estimates of wage elasticities. This section provides econometric estimates of labor demand functions by industry for production and other nonsupervisory employees.

There is no shortage of labor demand studies (see Hamermesh, 1976, for a recent survey), but existing studies are not fully satisfactory for the purposes of the particular policy simulations reported here. First, most of the existing econometric literature is based on highly aggregated data (usually at the level of all manufacturing industries) and, hence, does not allow comparison of program effects across industries. Second, the coverage of most previous studies has been limited to the manufacturing sector, which excludes industries such as wholesale and retail trade, services, and construction (among others) that are potential targets of a subsidy program. Third, some of these studies are now rather dated. For policy analysis and forecasting, it is desirable to have estimates based on the most recently available labor and production data.

Labor demand is analyzed in a partial equilibrium framework. Firms are assumed to be cost minimizers, subject to an output

constraint, and price-takers with respect to all inputs and outputs. The desired labor input is then subjected to a partial adjustment process to take into account employer search costs, delivery lags, and other adjustment costs. This yields a conditional labor demand function which depends on factor input prices, output level, and past employment levels. Before presenting the estimation results, the theoretical framework will be described in greater detail.

The technology employed by the representative firm in an industry is described by a production function of the form

$$Q_t = Q(K_t, L_t) \tag{3.1}$$

where Q_t, K_t, and L_t denote the levels of output, capital stock, and labor inputs, respectively, during period t. A competitive firm takes the prices of inputs and outputs as given and varies the levels of factor inputs so as to minimize the cost of producing the chosen level of output. This involves minimizing the cost function:

$$C(C_t, W_t) = C_tK_t + W_tL_t \tag{3.2}$$

subject to the quantity constraint (3.1), where C_t is the cost of a unit of capital and W_t is the wage paid for a unit of labor. Associated with the cost minimization problem is the Lagrangean:

$$\mathbb{L} = C_tK_t + W_tL_t + \lambda(Q_t - Q(K_t, L_t)) \tag{3.3}$$

For empirical work, it is convenient to assume that (3.1) is of the Cobb-Douglas form:

$$Q_t = AK_t^{\beta}L_t^{\gamma} \tag{3.4}$$

The associated Lagrangean is:

$$\mathbb{L} = C_t K_t + W_t L_t + \lambda(Q_t - \alpha K_t^{\beta} L_t^{\gamma}) \tag{3.5}$$

Differentiating (3.5) with respect to K_t and L_t:

$$\frac{\partial \mathbb{L}}{\partial K_t} = C_t - \lambda\beta A K_t^{\beta-1} L_t^{\gamma} = C_t - \lambda\beta Q_t/K_t = 0 \tag{3.6}$$

$$\frac{\partial \mathbb{L}}{\partial L_t} = W_t - \lambda\gamma A K_t^{\beta} L_t^{\gamma-1} = W_t - \lambda\gamma Q_t/L_t = 0 \tag{3.7}$$

Therefore:

$$\frac{C_t}{W_t} = \frac{\beta}{\gamma}(L_t/K_t) \tag{3.8}$$

Using $\log Q_t = \log A + \beta \log K_t + \gamma \log L_t$, some albegraic manipulation gives:

$$\begin{aligned}\log L_t &= \log\left(\frac{\gamma C_t}{\beta W_t}\right) + \log K_t \\ &= \log(\gamma/\beta) + \log C_t - \log W_t + \tfrac{1}{\beta}(\log Q_t - \log A - \gamma \log L_t) \\ &= \tfrac{1}{\beta+\gamma}[\beta \log(\gamma/\beta) - \log A] - \tfrac{\beta}{\beta+\gamma}[\log W_t - \log C_t] \\ &\quad + \tfrac{1}{\beta+\gamma} \log Q_t\end{aligned} \tag{3.9}$$

Rewriting (3.9) in a more convenient notation gives:

$$\ell_t = \alpha - \frac{\beta}{\theta}(w_t - c_t) + \frac{1}{\theta}q_t \tag{3.10}$$

where:

$$\ell_t = \log L_t,\ w_t = \log W_t,\ c_t = \log C_t,\ q_t = \log Q_t$$
$$\theta = \beta + \gamma,\ \alpha = \tfrac{1}{\theta}[\beta \log(\gamma/\beta) - \log A]$$

Two modifications need to be made to equation (3.10) before it is suitable for estimation. First, the constraint (implied by the

homogeneity of the production function) that wages and the cost of capital have equal, opposite signed coefficients in the labor demand function is strongly rejected by the data. Clark and Freeman (1981) argue that if capital prices are subject to measurement error, a better estimate of the wage elasticity is obtained by relaxing this constraint. Their argument is that if the observed log cost of capital c_t has reliability r, then the bias in estimating β/θ that results from imposing the constraint is:

$$\frac{(1 - r)\ \mathrm{var}(c_t)\ (\beta/\theta)}{\mathrm{var}(c_t) + \mathrm{var}(w_t) - 2\ \mathrm{cov}(c_t,w_t)} \tag{3.11}$$

When w_t and c_t are entered separately, the bias in estimating β/θ using the wage coefficient is:

$$\frac{(1 - r)\rho[\mathrm{var}(c_t)/\mathrm{var}(w_t)]}{1 - \rho^2} \tag{3.12}$$

where ρ is the correlation between c_t and w_t. If:

$$\mathrm{cov}(c_t,w_t) < \mathrm{var}(c_t) \tag{3.13}$$

then the estimating equation (3.10) without imposing the constraint produces a less biased estimate of β/θ. In fact, condition (3.13) is strongly confirmed in the data.

Second, equation (3.10) assumes that firms are able to respond instantaneously to changes in factor prices. To allow for the possibility of adjustment costs, delivery lags, and other factors which might hinder the firm's ability to substitute labor for other inputs, we impose a second order partial adjustment process on Equation (3.10). That is, if ℓ_t^* denotes the log of desired labor input, actual labor will be:

$$(\ell_t - \ell_{t-1}) + (\ell_t - \ell_{t-2}) = \lambda_1(\ell_t^* - \ell_{t-1}) + \lambda_2(\ell_t^* - \ell_{t-2}) \quad (3.14)$$

Then substituting (3.10) for ℓ_t^* and relaxing the homogeneity constraint yields:

$$\ell_t = (\lambda_1 + \lambda_2)(\alpha + \beta_1 w_t + \beta_2 c_t + \beta_3 q_t) \quad (3.15)$$
$$+ (1 - \lambda_1)\ell_{t-1} + (1 - \lambda_2)\ell_{t-2}$$

This is the basic equation for estimation of the industry labor demand models.

Labor input is measured by man hours per quarter (in thousands) for production and nonsupervisory workers. Industry output in measured by the industry's index of industrial production, when available, or otherwise gross domestic product for that industry. Wages are deflated by the consumer price index for all urban consumers. The user cost of capital is computed separately for structures and equipment with the respective costs weighted to form an overall cost of capital for that industry. The data are described in greater detail in Appendix A.

Several versions of Equation (3.15) were estimated with varying lag structures, with and without a (log) time trend, and over different time periods. The full set of regression estimates is reported in a more detailed version of this report (available upon request). The equations chosen for the policy simulations are presented in Table 1. In general, the selected models fit the data quite well with the lowest R^2 being 0.81 and most being in excess of

0.95. Plots of the predicted and actual labor demand indicate few large errors (see Figure 2). For a few industries (such as lumber and wood products, petroleum industries, and transportation equipment), work stoppages could not be predicted. These equations were reestimated removing strike periods without materially affecting the estimates.

Considerable variation in the elasticity of demand for labor was observed across industries. Short-run wage elasticities range from a very low -0.025 (in furniture and fixtures) to a very substantial -1.116 (in construction). Furthermore, adjustment rates also varied across industries. The prevalent pattern found was a one period lag with a mean lag between one and nine quarters. The industries exhibiting the fastest adjustment rates were trade, leather products, tobacco manufacturers, transportation equipment and services, and primary metals. Textile and apparel products, mining, and machinery were among the industries with the slowest adjustment rates.

TABLE 1

LABOR DEMAND MODELS

Industry	Constant	Wage	User Cost of Capital	Quantity	Trend	Labor (-1)	Labor (-2)	Estimation Period
Food & Kindred Products	1.444 (0.543)	-0.125 (0.042)	-0.005 (0.004)	0.016 (0.012)	0.006 (0.005)	0.851 (0.044)	— —	1948:2 - 1983:4 R^2 = 0.98
Tobacco Manufactures	2.308 (0.712)	-0.255 (0.056)	0.021 (0.010)	0.038 (0.048)	— —	0.535 (0.087)	0.149 (0.085)	1948:3 - 1981:1 R^2 = 0.98
Textile Mill Products	-0.668 (0.850)	-0.269 (0.150)	0.016 (0.009)	0.073 (0.044)	— —	1.304 (0.085)	-0.350 (0.088)	1948:3 - 1983:4 R^2 = 0.97
Apparel & Other Textiles	0.119 (0.718)	-0.058 (0.080)	0.006 (0.009)	0.017 (0.023)	0.002 (0.005)	0.974 (0.038)	— —	1948:3 - 1982:1 R^2 = 0.91
Lumber & Wood Products	-0.444 (0.566)	-0.375 (0.073)	0.048 (0.012)	0.279 (0.036)	-0.023 (0.009)	0.852 (0.033)	— —	1948:2-1983:4 R^2 = 0.94
Furniture & Fixtures	1.019 (0.614)	-0.025 (0.101)	0.005 (0.008)	0.041 (0.022)	— —	0.895 (0.041)	— —	1948:2 - 1983:4 R^2 = 0.95
Paper & Allied Products	0.989 (0.494)	-0.450 (0.067)	0.005 (0.008)	0.155 (0.023)	0.037 (0.006)	0.735 (0.049)	— —	1948:2 - 1983:4 R^2 = 0.98
Printing & Publishing	0.893 (0.318)	-0.054 (0.044)	0.001 (0.005)	0.033 0.018	0.009 (0.003)	0.901 (0.026)	— —	1948:2 - 1983:4 R^2 = 0.99

TABLE 1 (cont.)

LABOR DEMAND MODELS

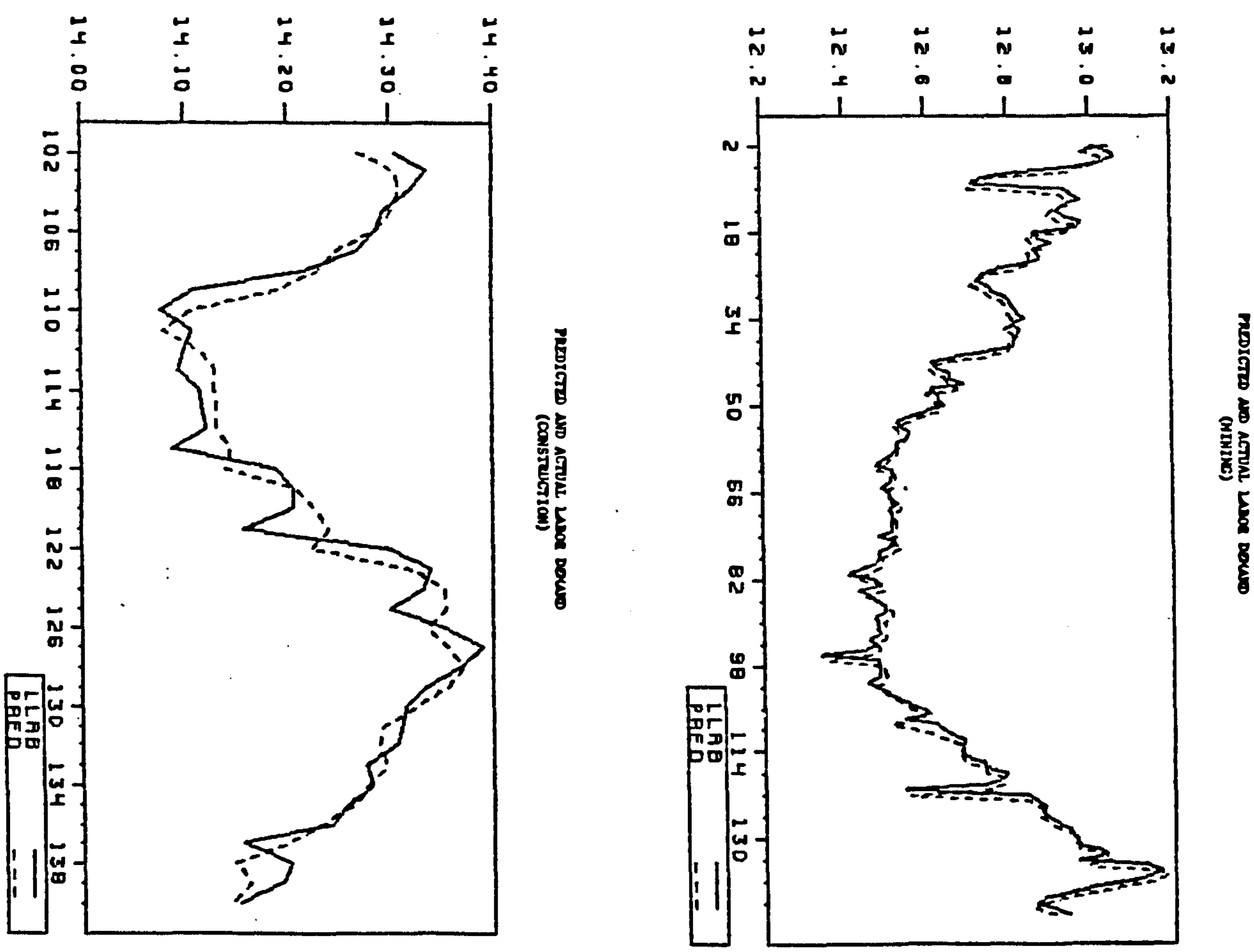
Industry	Constant	Wage	User Cost of Capital	Quantity	Trend	Labor (-1)	Labor (-2)	Estimation Period
Chemical & Allied Products	1.511 (0.315)	-0.330 (0.055)	-0.003 (0.004)	0.087 (0.012)	0.020 (0.005)	1.145 (0.076)	-.0389 (0.064)	1948:3 - 1983:4 R^2 = 0.99
Petroleum Industries	0.893 (0.513)	-0.051 (0.062)	-0.037 (0.208)	0.014 (0.044)	—	0.898 (0.041)	—	1948:2 - 1983:4 R^2 = 0.87
Rubber & Plastic Products	3.031 (0.487)	-0.089 (0.069)	-0.009 (0.008)	0.131 (0.022)	— —	1.000 (0.081)	-0.323 (0.075)	1948:3 - 1983:4 R^2 = 0.99
Leather & Leather Products	1.123 (0.362)	-0.430 (0.078)	0.037 (0.009)	0.522 (0.049)	-0.022 (0.006)	0.592 (0.041)	— —	1948:2 - 1983:4 R^2 = 0.99
Stone, Clay & Glass	0.420 (0.499)	-0.484 (0.109)	-0.014 (0.010)	0.181 (0.038)	0.022 (0.009)	1.109 (0.088)	-0.350 (0.077)	1948:3 - 1983:4 R^2 = 0.93
Primary Metal	2.996 (0.387)	-0.557 (0.043)	0.032 (0.014)	0.452 (0.032)	— —	0.493 (0.041)	— —	1948:2 - 1983:4 R^2 = 0.91
Fabricated Metals	0.632 (0.577)	-0.572 (0.157)	-0.026 (0.157)	0.204 (0.040)	0.045 (0.017)	1.097 (0.088)	-0.378 (0.074)	1948:3 - 1983:4 R^2 = 0.97
Machinery Excluding Electrical	0.872 (0.490)	-0.340 (0.138)	-0.014 (0.009)	0.108 (0.024)	0.021 (0.014)	1.535 (0.062)	-0.729 (0.052)	1948:3 - 1983:4 R^2 = 0.99
Electrical Machinery	0.723 (0.517)	-0.261 (0.087)	0.009 (0.015)	0.092 (0.020)	— —	0.851 (0.037)	— —	1948:2 - 1983:4 R^2 = 0.97

TABLE 1 (cont.)

LABOR DEMAND MODELS

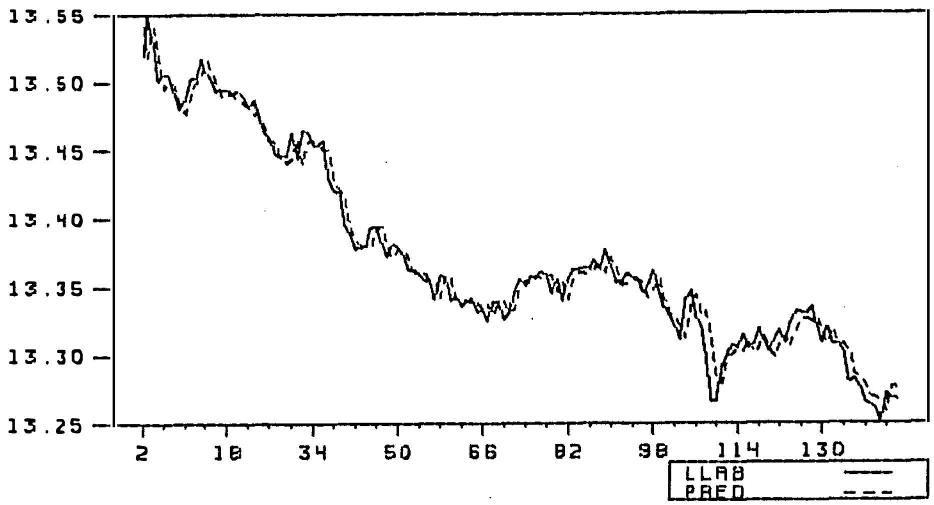
Industry	Constant	Wage	User Cost of Capital	Quantity	Trend	Labor (-1)	Labor (-2)	Estimation Period
Transportation Equipment	2.706 (0.436)	-1.322 (0.108)	0.040 (0.019)	0.857 (0.065)	— —	0.213 (0.059)	— —	1964:2 - 1983:4 $R^2 = 0.93$
Instruments	0.190 (0.371)	-0.243 (0.010)	0.019 (0.006)	0.050 (0.011)	0.021 (0.012)	1.635 (0.058)	-0.739 (0.054)	1948:3 - 1983:4 $R^2 = 0.99$
Miscellaneous Products	1.017 (0.441)	-0.035 (0.074)	0.001 (0.008)	0.005 (0.016)	— —	1.396 (0.079)	-0.493 (0.081)	1948:3 - 1983:1 $R^2 = 0.90$
Mining (MI)	-0.669 (0.919)	-0.145 (0.132)	0.023 (0.028)	0.139 (0.087)	— —	0.973 (0.260)	—	1948:2 - 1983:4 $R^2 = 0.94$
Construction (CC)	0.532 (1.372)	-1.116 (0.622)	-0.005 (0.024)	0.406 (0.125)	-0.173 (0.184)	0.722 (0.082)	— —	1973:2 - 1982:4 $R^2 = 0.85$
Transportation & Utilities (TU)	10.894 (0.691)	-0.554 (0.186)	-0.021 (0.008)	0.803 (0.098)	-0.213 (0.004)	— —	— —	1973:1 - 1982:4 $R^2 = 0.81$
Trade (T)	5.983 (1.452)	-0.269 (0.166)	-0.001 (0.009)	0.258 (0.074)	0.020 (0.017)	0.570 (0.096)	—	1967:2 - 1982:4 $R^2 = 0.98$
Services (S)	2.673 (0.508)	-0.050 (0.020)	-0.002 (0.003)	0.229 (0.044)	— —	0.763 (0.044)	— —	1964:2 - 1982:4 $R^2 = 0.99$
Finance & Real Estate (FR)	2.740 (1.097)	-0.005 (0.119)	-0.009 (0.006)	0.271 (0.155)	-0.038 (0.057)	0.741 (0.095)	— —	1973:2 - 1982:4 $R^2 = 0.99$

FIGURE 2

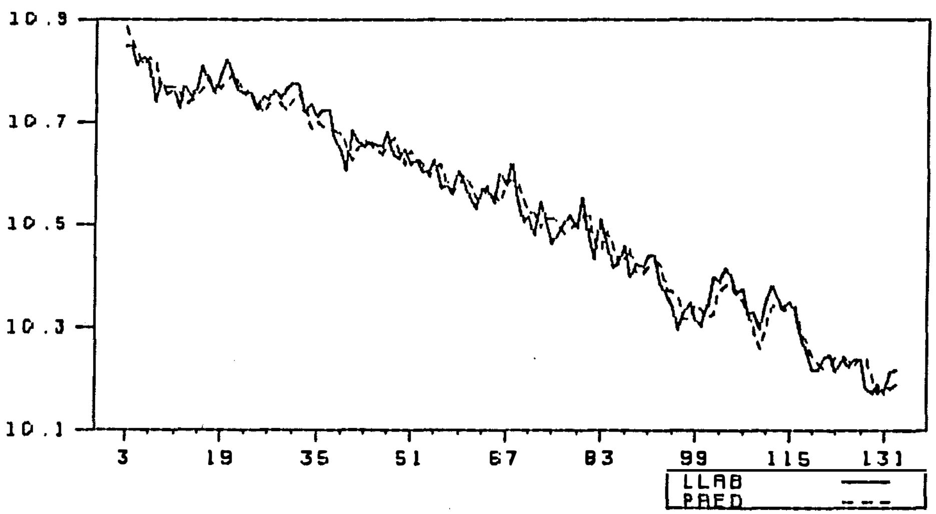


KEY:
Log of thousands of manhours per quarter.
Period 1 is 1948:1.

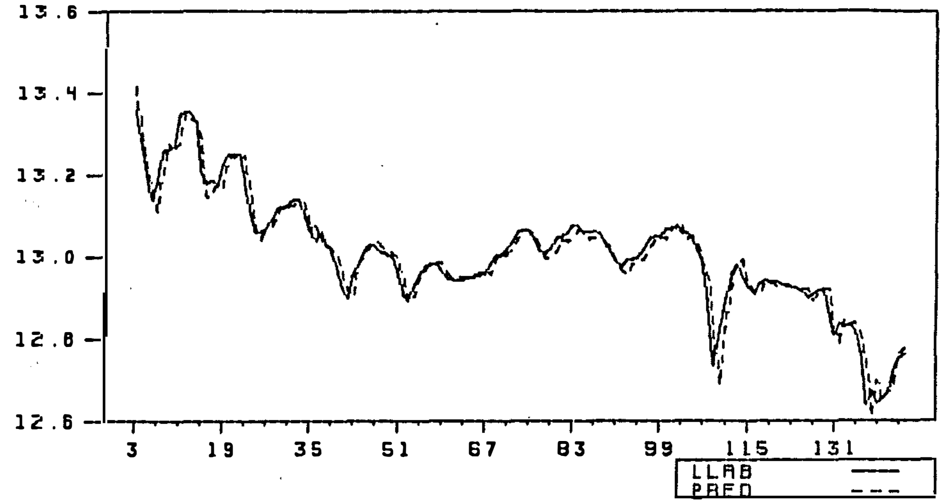
PREDICTED AND ACTUAL LABOR DEMAND
(FOOD AND KINDRED PRODUCTS)



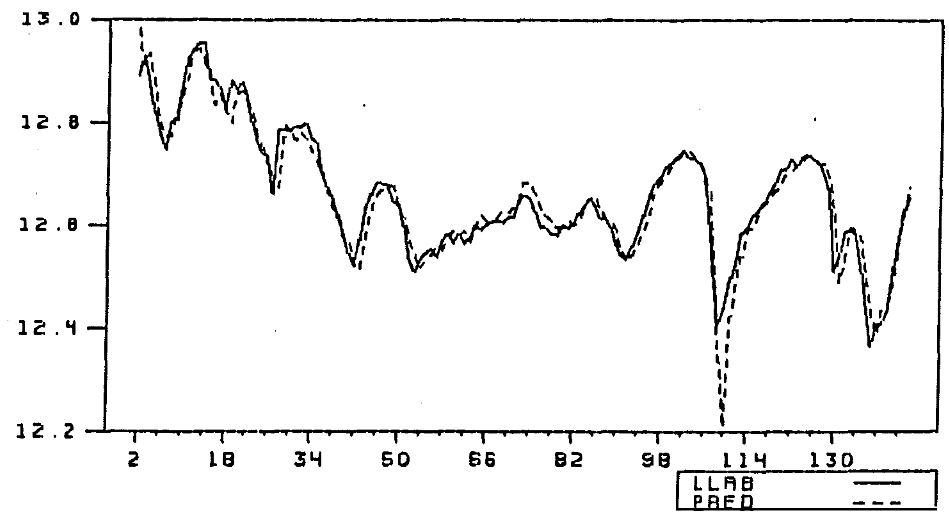
PREDICTED AND ACTUAL LABOR DEMAND
(TOBACCO MANUFACTURES)



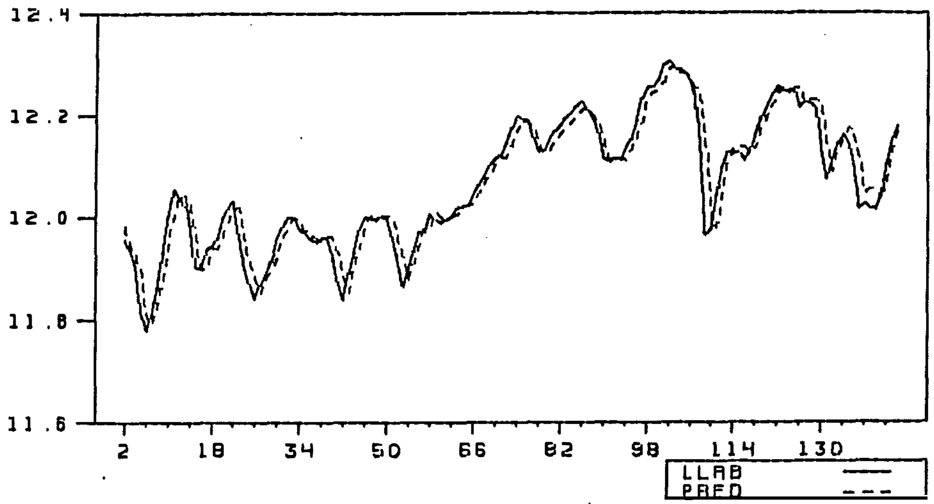
PREDICTED AND ACTUAL LABOR DEMAND
(TEXTILE MILL PRODUCTS)



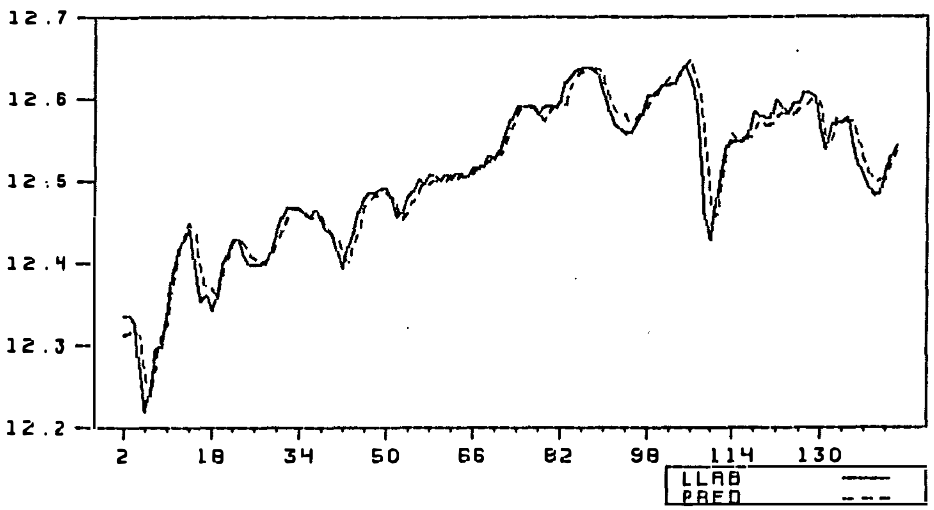
PREDICTED AND ACTUAL LABOR DEMAND
(LUMBER AND WOOD PRODUCTS)



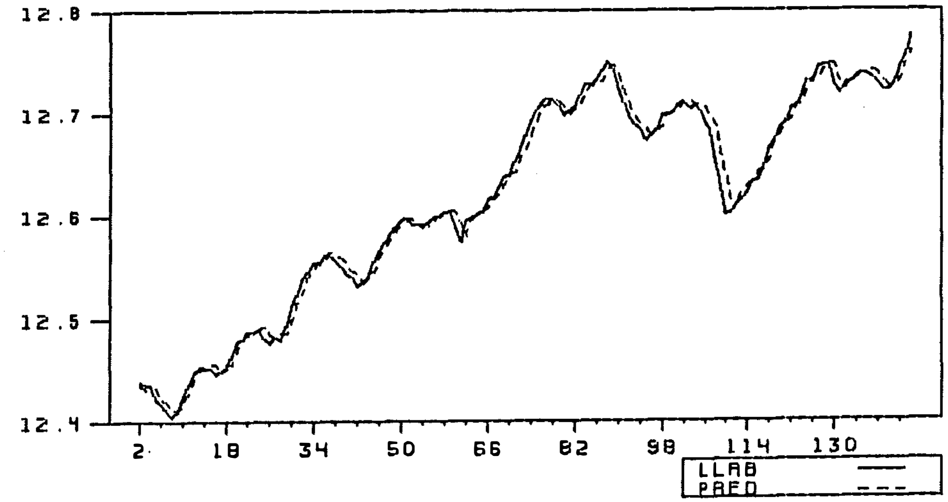
PREDICTED AND ACTUAL LABOR DEMAND
(FURNITURE AND FIXTURES)



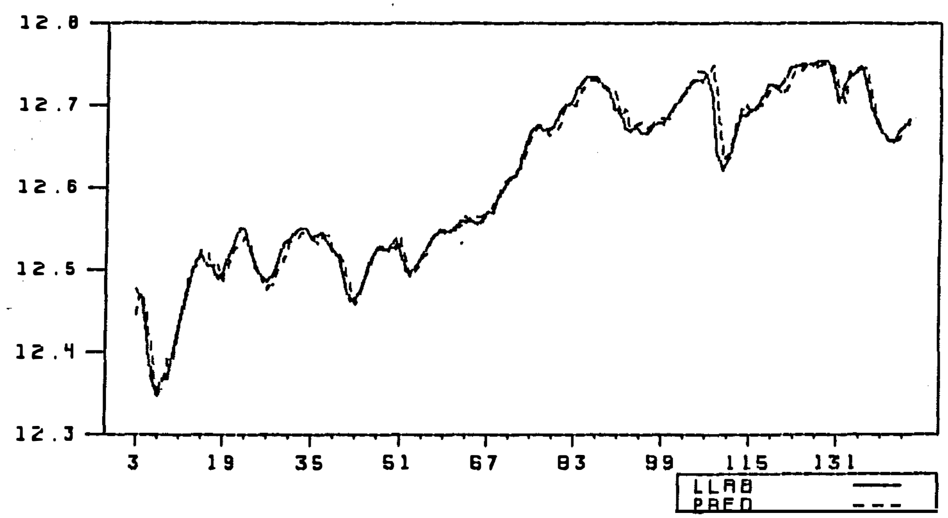
PREDICTED AND ACTUAL LABOR DEMAND
(PAPER AND ALLIED PRODUCTS)



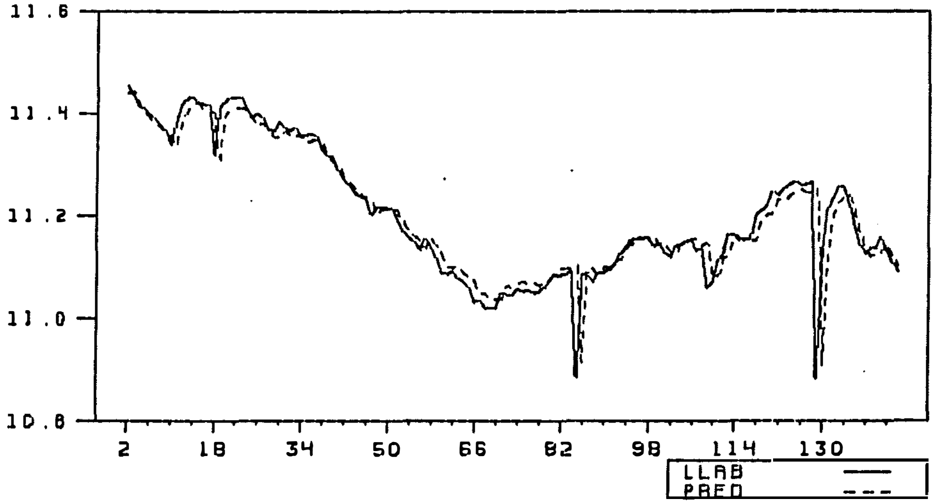
PREDICTED AND ACTUAL LABOR DEMAND
(PRINTING AND PUBLISHING)



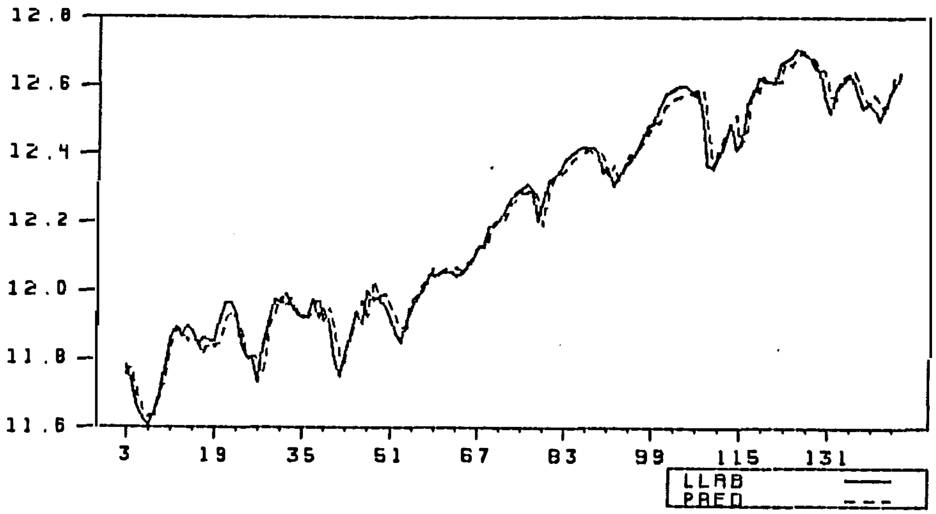
PREDICTED AND ACTUAL LABOR DEMAND
(CHEMICAL AND ALLIED PRODUCTS)



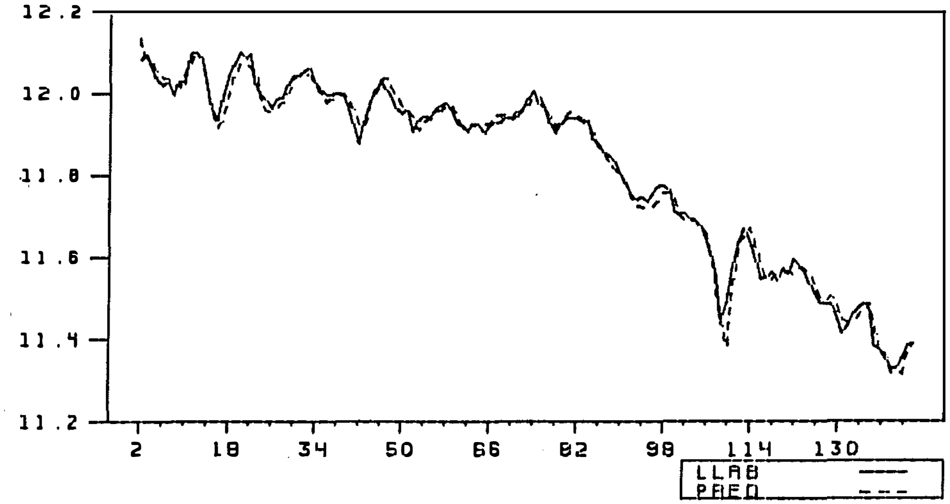
PREDICTED AND ACTUAL LABOR DEMAND
(PETROLEUM INDUSTRIES)



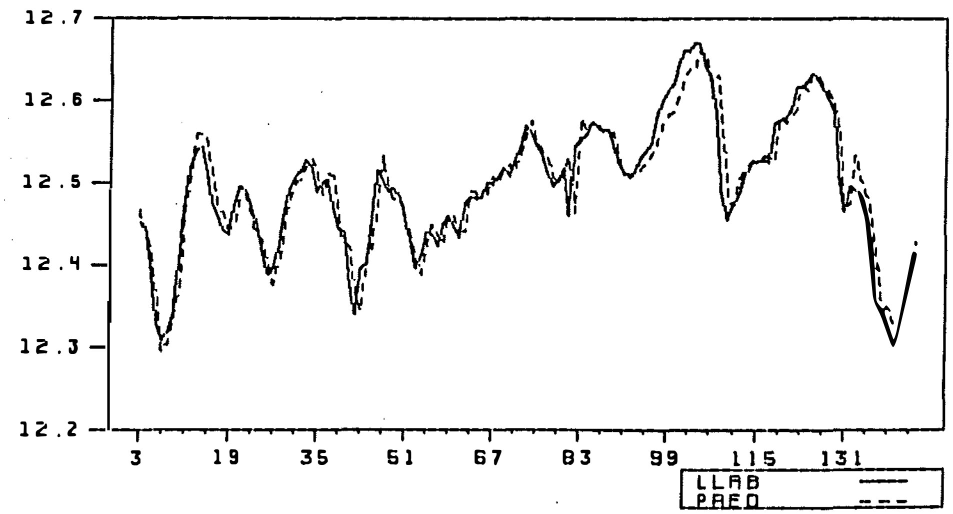
PREDICTED AND ACTUAL LABOR DEMAND
(RUBBER AND PLASTIC PRODUCTS)



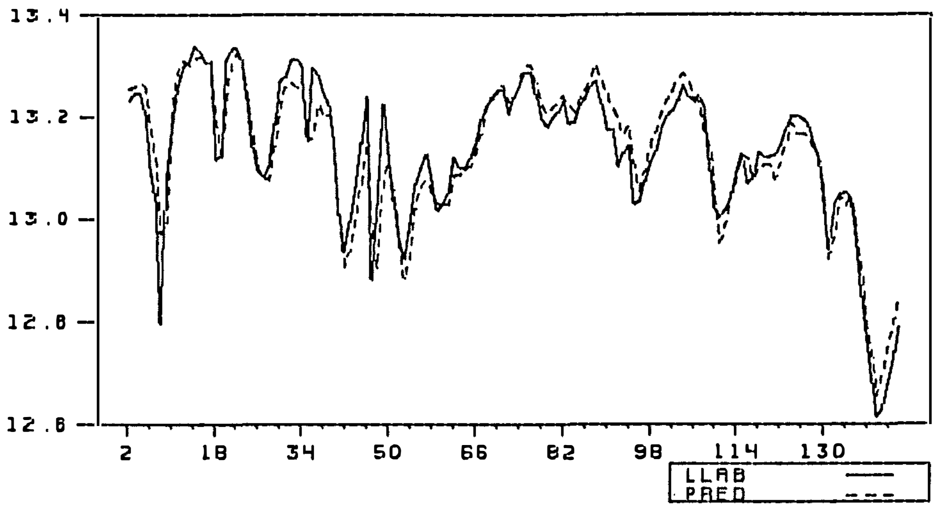
PREDICTED AND ACTUAL LABOR DEMAND
(LEATHER AND LEATHER PRODUCTS)



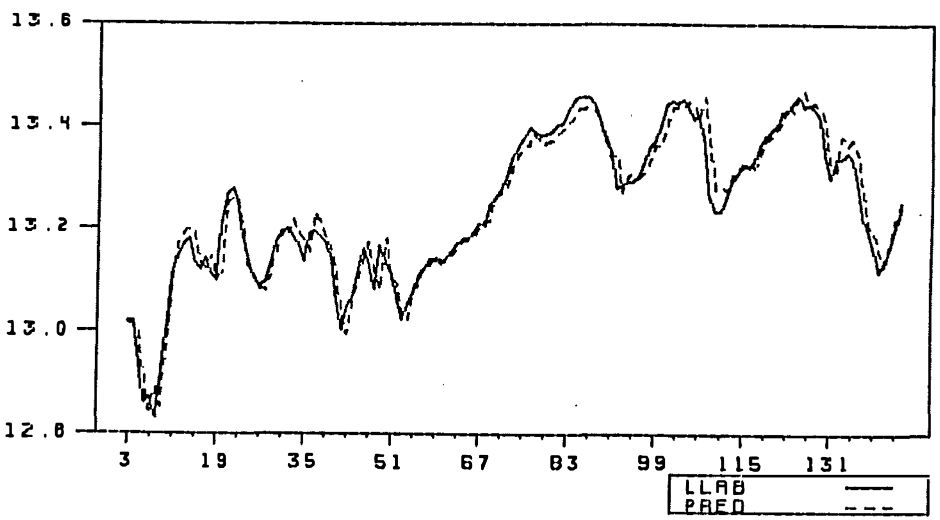
PREDICTED AND ACTUAL LABOR DEMAND
(STONE, CLAY, AND GLASS)



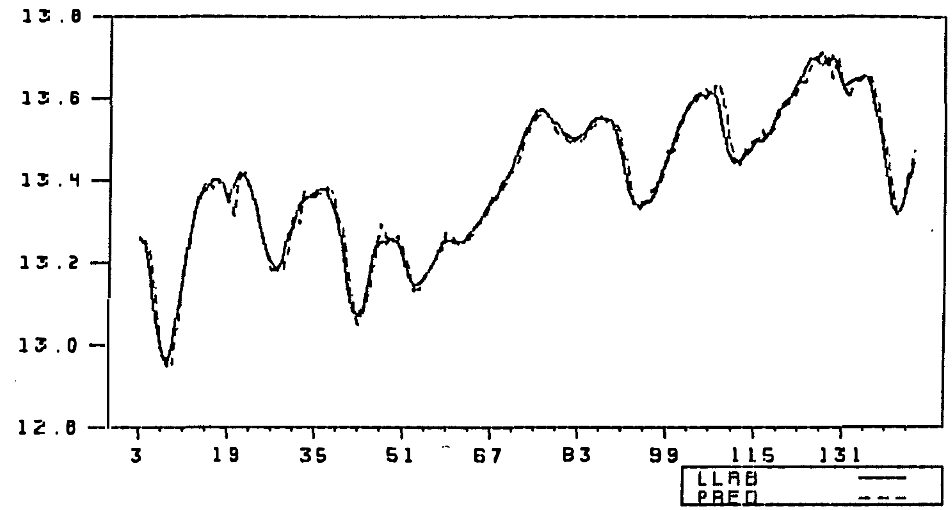
PREDICTED AND ACTUAL LABOR DEMAND
(PRIMARY METAL)



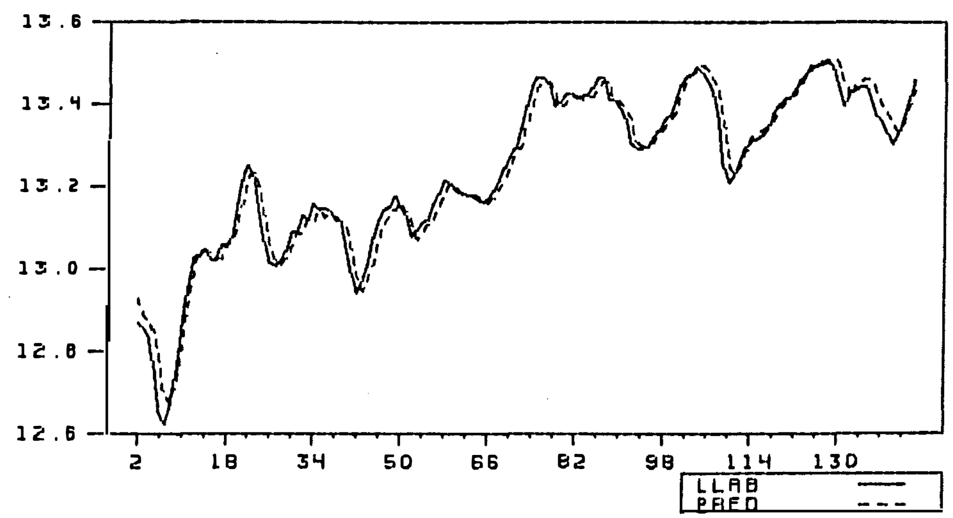
PREDICTED AND ACTUAL LABOR DEMAND
(FABRICATED METALS)



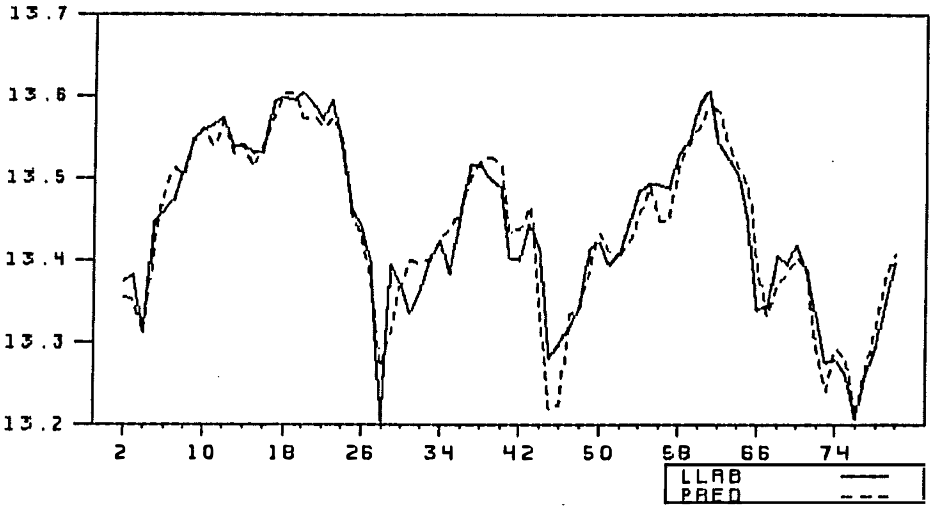
PREDICTED AND ACTUAL LABOR DEMAND
(MACHINERY EXCLUDING ELECTRICAL)



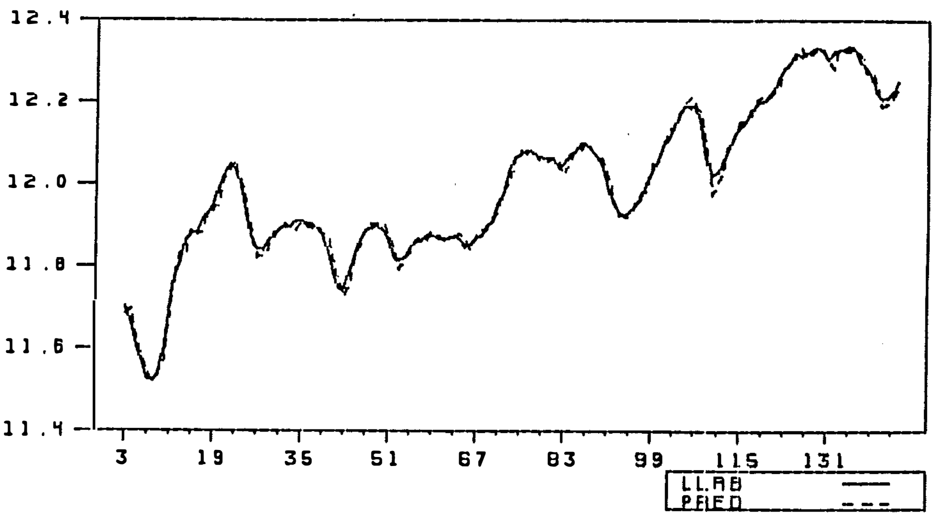
PREDICTED AND ACTUAL LABOR DEMAND
(ELECTRICAL MACHINERY)



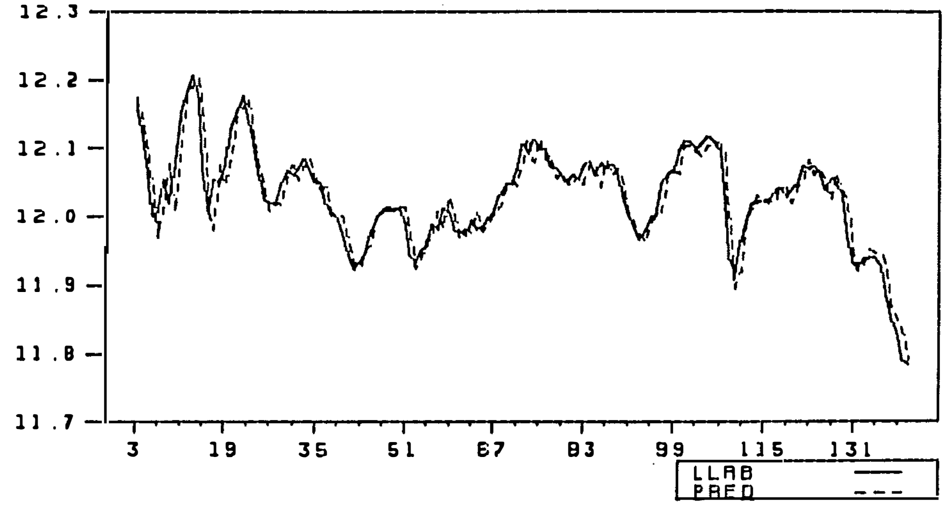
PREDICTED AND ACTUAL LABOR DEMAND
(TRANSPORTATION EQUIPMENT)



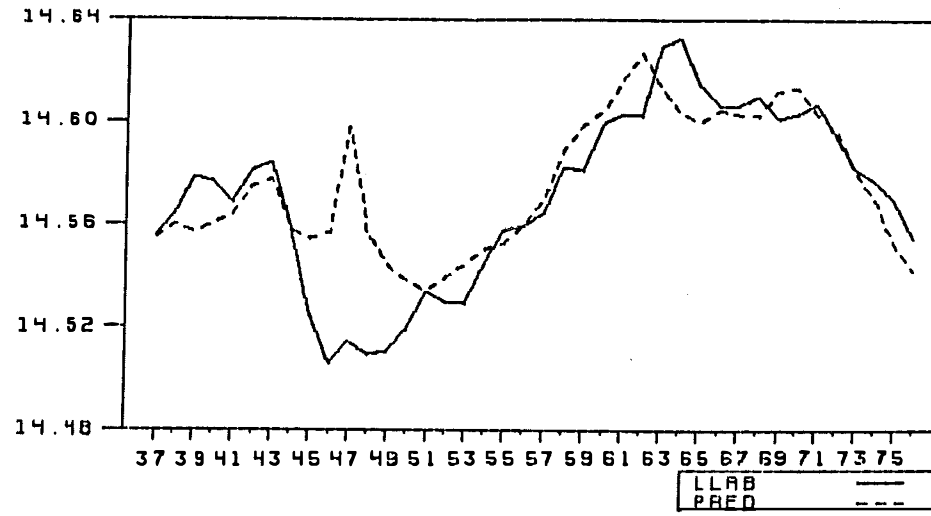
PREDICTED AND ACTUAL LABOR DEMAND
(INSTRUMENTS)



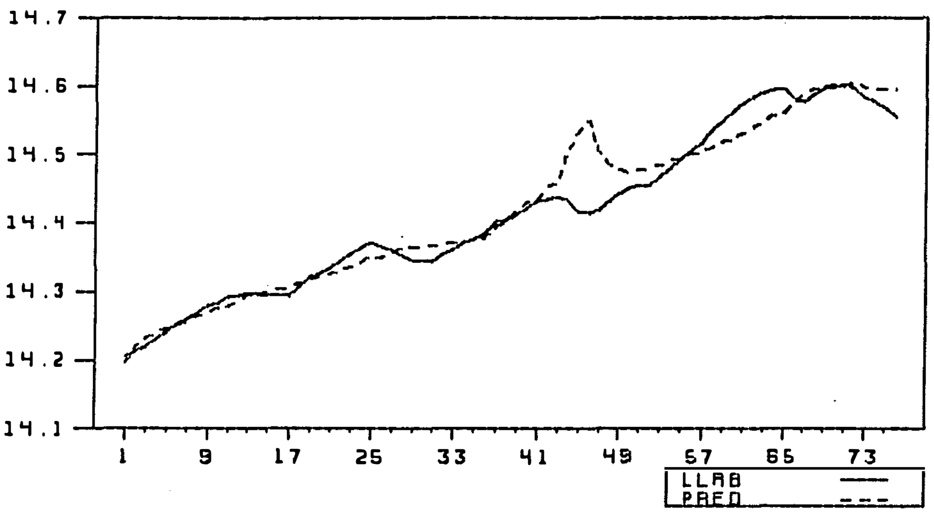
PREDICTED AND ACTUAL LABOR DEMAND
(MISCELLANEOUS PRODUCTS)



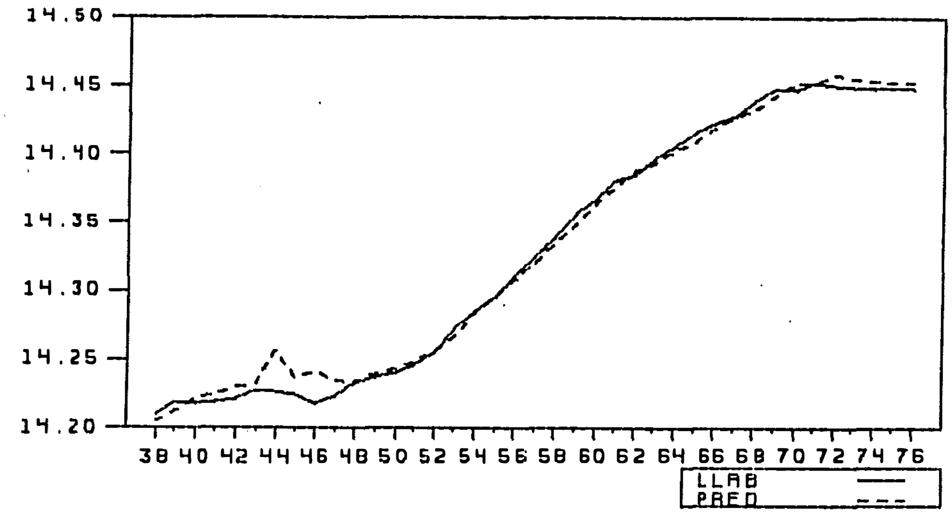
PREDICTED AND ACTUAL LABOR DEMAND
(TRANSPORTATION AND UTILITIES)



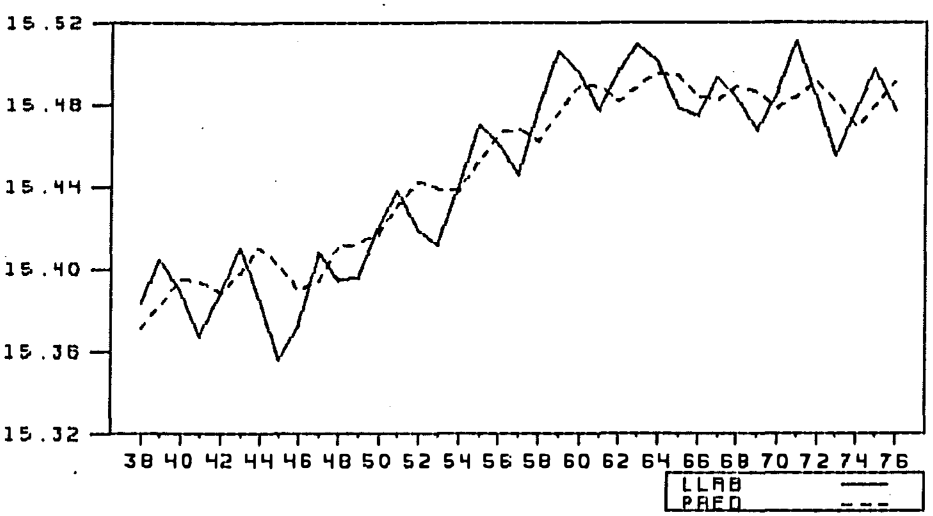
PREDICTED AND ACTUAL LABOR DEMAND
(WHOLESALE TRADE)



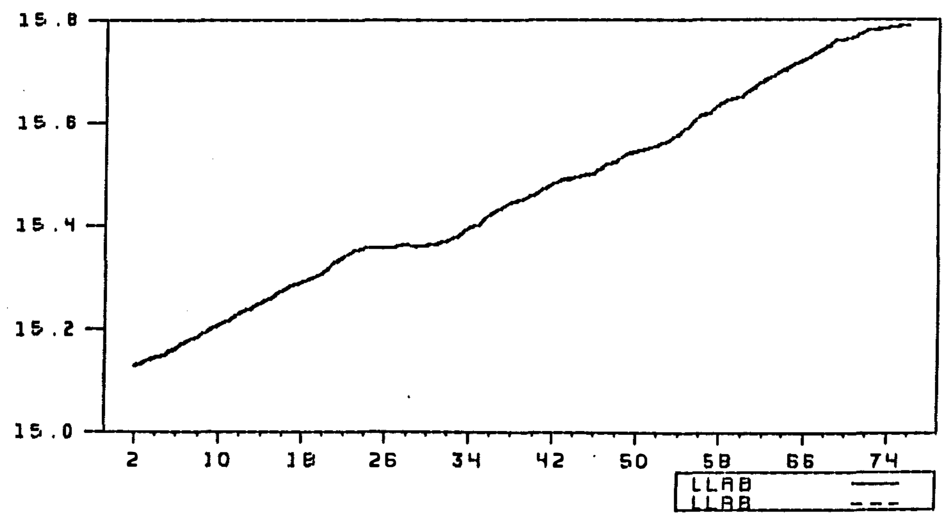
PREDICTED AND ACTUAL LABOR DEMAND
(FINANCE AND REAL ESTATE)



PREDICTED AND ACTUAL LABOR DEMAND
(RETAIL TRADE)



PREDICTED AND ACTUAL LABOR DEMAND
(SERVICES)



4. Input/Output Analysis

In this section we describe the use of the input/output technique to determine industry output for a specified level of final demand. We begin with a short review of the input/output method which is followed by a discussion of the construction of the tables used in our forecasting study. We then describe modifications to the input/output method to capture major trends and changes in each industry.

4.1 Review of Theory

Suppose for simplicity that there are m industries which produce m goods. A linear production activity for the j^{th} industry is denoted by the coefficient $a_{ij} \geq 0$ which measures the minimum input of commodity i necessary to produce 1 unit of commodity j.

Given a level of final demand, f_i, for the product of industry i we have the accounting relation:

$$q_i = a_{i1}q_1 + a_{i2}q_2 + \cdots + a_{im}q_m + f_i \quad i = 1,2,\ldots,m \tag{4.1}$$

which simply states that the output of industry i is equal to the use of commodity i by all industries (including industry i) plus final demand. Combining all industries yields:

$$(I - A)q = f$$

where I is an m x m identity matrix, A has typical element a_{ij} and q and f are m x 1 column vectors. For any level $f \geq 0$ of final demand, we find an associated level of industry output by solving the linear

system (4.1) to obtain:

$$q = (I - A)^{-1}f \tag{4.2}$$

In order to solve the set of simultaneous equations the levels of final demand, f_i need to be determined. We follow the general methods of the Bureau of Economic Analysis and express the final demands in each industry as fractions of the components of aggregate demand, Personal Consumption Expenditure (PCE), gross private fixed investment (FDGI), the change in Business Inventories (ΔINV), net exports (NEXP), Federal government expenditures (FED), and state and local government expenditures (GOV). The coefficients which define the decomposition of aggregate demand into final demand are grouped together into an "industry bridge."

Denote by Z the column vector of aggregate demand components. Then we write:

$$f_i = b_{i1}Z_1 + b_{i2}Z_2 + \cdots b_{i6}Z_6 \quad i = 1,2,\ldots m \tag{4.3}$$

where $b_{ij} \geq 0$ denotes the fraction of aggregate demand j which is spent on commodity i. In matrix notation we write:

$$f = BZ \tag{4.4}$$

where B is the (m x 6) matrix with typical element b_{ij}. Combining equations (4.2) and (4.4) we obtain:

$$q = (I - A)^{-1}BZ \tag{4.5}$$

which relates output by industry to the levels of aggregate demand.

4.2 Construction of the Input-Output and Bridge Tables

The data used to develop the input/output coefficient matrices A and B was obtained from the U.S. Department of Commerce, Bureau of Economic Analysis (1983). The 1979 data represent the most current published data available for input/output analysis and are presented in summary form for 85 industries and commodities. In the preparation of the input/output and bridge tables, we assigned 85 Commerce Department industries to the industries in our model. The input/output table and aggregation information are provided in Appendix B.

To check the internal validity of the input/output numbers and to determine any substantive errors introduced in the aggregation of the commerce department data, we calculated row and column totals of the raw input/output and bridge matrices. We compared the row totals and column totals with corresponding aggregates of commerce department totals and found excellent agreement. Furthermore, we determined that the numbers were internally consistent in that we found close agreement between the column totals of the I/O matrix (including value added) and the sum of the row totals of the I/O and Bridge Tables. Each necessarily is a measure of the total output of the industry and therefore we expect agreement in these totals.

To generate the I/O and Bridge coefficients we divided each column by its column total. The final I/O coefficient matrix (now excluding the 30th row) was differenced from the identity matrix and inverted. The resulting Leontref matrix was checked to be positive.

As a final check we calculated $(I - A)^{-1}BZ$ using historical aggregate demand data for 1979. Again we found close aggreement between the predicted 1979 output levels and the total outputs given by the column totals of the I/O table.

4.3 Modifications to the Input/Output Analysis

Many of the uses of input/output analysis involve the simplifying assumption that the relationships established for the base year (1979 in our study) that link inputs to outputs will remain stable over time and through a range of output levels. The use of input/output analysis in forecasting does not rest on the theoretical validity of stability or proportionality. Rather, we assume that small changes in the output of an industry are unlikely to result in significant economies or diseconomies for most materials. Of course, for some inputs the proportionality assumption is questionable.

To manage the non-stationarity in the input/output analysis we employ a regression correction which compars actual with predicted outputs. Specifically, we compute a real output index:

$$\hat{I}_t = [(\frac{\hat{q}_t}{P_t}) - [(\frac{\hat{q}_{67}}{P_{67}})] \qquad \text{where:} \qquad (4.6)$$

$\hat{q}_t = (I - A)^{-1}BZ_t$, $\hat{q}_{67}$ = 1967 predicted output averaged over four quarters, P_t = Implicit Price Deflator (1972 = 100), and Z_t = aggregate demand in period t. We then calculate the industry by industry regressions:

$$IPI_t = \alpha_0 + \alpha_1(\hat{I}_t - \hat{I}_{t-4}) + \alpha_2 t + \alpha_3 IPI_{t-1} + \xi_t \qquad (4.7)$$

where IPI_t = actual industrial production index in period t.

The results of the industry "transfer" regressions are shown

in Table 3. We note that the estimated coefficients were generally significant and of the expected sign. While the majority of the equations explained a large amount of the variance, we do note that some industries (Tobacco Manufactures and Chemical and Allied Products) appear to have undergone structural shifts not well represented in the input/output and transfer analyses. Overall, we conclude that input/output analysis is an efficient mechanism for translating aggregate demand into measures of real industrial production.

TABLE 3
INDUSTRY TRANSFER EQUATIONS

INDUSTRY	CONSTANT	ΔQ	TREND	IPI(-1)	R^2
Mining	31.501 (27.519)	0.002 (0.052)	-0.415 (0.377)	0.934 (0.211)	0.629
Construction	7.53 (2.04)	0.008 (0.006)	-0.066 (0.016)	0.702 (0.887)	0.983
Food & Kindred Products	54.263 (23.505)	0.056 (0.054)	0.204 (0.106)	0.565 (0.191)	0.867
Tobacco Manufactures	61.116 (30.505)	0.002 (0.033)	--- ---	0.486 (0.255)	0.176
Textile Mill Products	30.221 (28.904)	0.187 (0.071)	-0.099 (0.219)	0.821 (0.145)	0.782
Apparel & Other Textiles	35.955 (38.086)	0.028 (0.040)	-0.468 (0.259)	0.903 (0.200)	0.907
Lumber & Wood Products	22.124 (35.901)	0.129 (0.100)	0.180 (0.356)	0.738 (0.171)	0.664
Furniture & Fixtures	28.140 (21.626)	0.398 (0.960)	0.040 (0.193)	0.807 (0.126)	0.815
Paper & Allied Products	33.876 (26.856)	0.110 (0.060)	0.242 (0.174)	0.694 (0.200)	0.733
Printing & Publishing	14.564 (27.679)	0.071 (0.088)	0.319 (0.240)	0.776 (0.272)	0.792
Chemical & Allied Products	53.031 (48.485)	0.103 (0.132)	0.131 (0.297)	0.714 (0.203)	0.498
Petroleum Industries	160.944 (77.572)	0.093 (0.117)	-0.668 (0.427)	0.547 (0.208)	0.674

TABLE 3 (cont.)

INDUSTRY	CONSTANT	ΔQ	TREND	IPI(-1)	R^2
Rubber & Plastic Products	49.088 (39.132)	0.630 (0.153)	0.321 (0.340)	0.754 (0.137)	0.805
Leather & Leather Products	41.689 (27.077)	0.004 (0.006)	-0.327 (0.177)	0.647 (0.260)	0.845
Stone, Clay & Glass	68.247 (48.650)	0.333 (0.122)	-0.454 (0.435)	0.710 (0.175)	0.819
Primary Metal	97.003 (40.341)	0.280 (0.061)	-1.067 (0.475)	0.631 (0.139)	0.904
Fabricated Metals	52.105 (39.172)	0.340 (0.090)	-0.419 (0.354)	0.783 (0.150)	0.908
Machinery Excluding Electrical	45.480 (35.036)	0.106 (0.076)	-0.175 (0.264)	0.781 (0.150)	0.748
Electrical Machinery	13.821 (30.820)	0.220 (0.079)	0.158 (0.190)	0.878 (0.178)	0.717
Transportation Equipment	27.990 (36.571)	0.424 (0.151)	-0.053 (0.343)	0.781 (0.156)	0.824
Instruments	96.892 (46.537)	0.112 (0.062)	-0.450 (0.231)	0.577 (0.203)	0.863
Miscellaneous	64.072 (31.509)	0.223 (0.086)	-0.339 (0.224)	0.698 (0.153)	0.728
Transportation & Utilities	5.121 (4.551)	0.014 (0.007)	-0.024 (0.012)	0.894 (0.135)	0.800
Trade	0.193 (0.076)	0.000 (0.000)	-0.000 (0.000)	0.626 (0.155)	0.672
Finance & Real Estate	1.367 (3.532)	0.005 (0.007)	-0.031 (0.065)	1.014 (0.120)	0.997
Services	0.150 (2.773)	0.010 (0.007)	-0.051 (0.064)	1.065 (0.133)	0.997

4.4 Forecasting Industrial Production

To use the input/output analysis for forecasting we assume two baseline (pre-policy) scenarios for aggregate demand. We begin with forecasts of personal consumption expenditure, gross private domestic investment, change in business inventories, net exports, and federal, and state and local expenditures taken from the American Statistical Association and the National Bureau of Economic Research (ASA/NBER). Additionally, we use projections of the implicit price deflator. Five quarters are projected by ASA/NBER; we extrapolated an additional 3 more quarters thus forecasting 8 quarters in all. Note that actual data ends in 1984:2 second quarter so that our forecast period extends from 1984:3 to 1986:2.

The baseline forecast is presented in Table 4. We have also computed a scenario in which demand declines uniformly at a rate of 1.5 percent per quarter, given in Table 5.

TABLE 4
BASE FORECAST VALUES-CURRENT DOLLARS*

	PCE	FDGI	ΔINV	NEXP	FED	S&L	IPD
84:3	2376.7	595.1	52.7	-58.9	312.1	457.8	226.0
84:4	2424.0	603.9	50.2	-56.0	321.1	466.1	228.8
85:1	2475.2	619.4	50.9	-45.3	327.8	474.0	231.8
85:2	2530.3	632.1	48.4	-38.4	337.5	481.9	235.0
85:3	2583.6	647.4	47.2	-33.6	346.5	490.3	237.9
85:4	2637.9	663.1	45.9	-29.0	355.6	498.7	240.9
86:1	2693.4	679.3	44.8	-25.1	365.0	507.3	244.0
86:2	2570.2	695.8	43.8	-21.5	374.6	515.9	247.1

TABLE 5
RECESSION FORECAST (1.5% decrease in real terms)-CURRENT DOLLARS

PERIOD	PCE	FDGI	ΔINV	NEXP	FED	S&L	IPD
84:2	2326.7	577.9	53.8	-58.0	299.3	446.7	223.0
84:3	2322.6	576.9	53.7	-57.9	298.8	445.9	226.0
84:4	2316.1	575.3	53.5	-57.7	297.9	444.7	228.8
85:1	2311.3	574.1	53.4	-57.6	297.3	443.8	231.8
85:2	2308.1	573.3	53.3	-57.5	296.9	443.2	235.0
85:3	2301.5	571.7	53.1	-57.3	296.1	441.9	237.9
85:4	2295.6	570.2	52.9	-57.2	295.3	440.8	240.9
86:1	2290.3	568.9	52.8	-57.1	294.6	439.8	244.0
86:2	2284.6	567.5	52.7	-56.9	293.9	438.7	247.1

*In Tables 4 and 5:

PCE - Personal Consumption Expenditure
FDGI - Gross Private Fixed Investment
ΔINV - Change in Business Inventories
NEXP - Net Exports
FED - Federal Expenditures
S&L - State and Local Expenditures
IPD - Implicit Price Deflator

Data are forecasted in periods 84:3 to 86:2.

Note that in each scenario, we maintain the ASA/NBER projections for the implicit price deflator and use these projections to extrapolate the industry sepecific price deflators.

A forecast in our model thus consists of four steps:

(1) Assume a baseline forecast for aggregate demand;

(2) Modify components of aggregate demand which are induced by the PEP program when present;

(3) Compute an estimate of real industrial production (Equation (4.6)).

(4) Adjust the estimate in step (3) using the regression transfer corrections (Equation (4.7)).

5.1 <u>Unemployment Insurance and the Productive Employment Program</u>

Currently, unemployment insurance provides a weekly cash payment to experienced workers who are involuntarily unemployed. Persons who voluntarily left their jobs, persons formerly working for employers exempted from the program, and persons whose total wages or length of employment in the preceding year fell below minimum eligibility requirements are not covered by the program. In addition recipients are required to seek new employment, though they are not required to accept a job if the job is available due to a strike or other labor dispute, or if the individual would be required to either join or not join a union, or if the conditions of work are substantially inferior to the recipient's prior position. The definition of "suitable work" varies from state to state. Typically, between 40 and 50 percent of those identified as unemployed in national employment surveys are insured under the program, though this fraction can be somewhat higher in periods when benefits have been temporarily extended. The coverage of the program is quite extensive. All fifty states, the District of Columbia, Puerto Rico, and the Virgin Islands operate programs and nearly all employers (except for self employment, certain agricultural labor and domestic service, and service for relatives) are required to pay UI payroll taxes. It is estimated that nearly 97% of all wage and salary workers and about 88% of all employed persons work in jobs such that, if they accumulated sufficient experience, they would qualify for UI benefits.

Although the program is funded through a payroll tax to the

Federal Unemployment Trust Fund and the federal government sets general guidelines and restrictions on benefits and eligibility, exact eligibility requirements and compensation levels are set by the states who administer the program. For this reason, it is difficult to precisely characterize the current program. Table 6 presents the range of weekly benefits, duration of benefits, and minimum earnings requirements that states have chosen. Typically, if a worker qualifies for the program, he or she will be eligible for up to 26 weeks of benefits with an average weekly benefit of between $125, with the maximum weekly benefit not to exceed $258.

TABLE 6
SELECTED BENEFIT AND ELIGIBILITY INFORMATION FOR REGULAR STATE UNEMPLOYMENT INSURANCE PROGRAMS, BY STATE, JANUARY 1983
(In dollars and weeks of benefits)

State	Weekly Benefit Min.	Max.	Avg.(b)	Duration Min.	Max.	Earnings Requirements Min.	Max.
Alabama	15	90	81	11	26	522	7,020
Alaska	34	228	132	16	26	1,000	16,000
Arizona	40	115	105	12	26	1,500	8,969
Arkansas	31	136	97	10	26	930	10,605
California	30	166	101	12	26	1,200	8,630
Colorado	25	190	148	7	26	1,000	19,656
Connecticut	15	206	119	26	26	600	6,240
Delaware	20	150	98	18	26	720	15,496
District of of Columbia	13	206	145	17	34	450	14,006
Florida	10	125	97	10	26	400	12,897
Georgia	27	115	98	4	26	413	11,956
Hawaii	5	178	129	26	26	150	5,340
Idaho	36	159	118	10	26	1,138	13,351
Illinois	51	224	151	26	26	1,600	4,789
Indiana	40	141	96	9	26	1,500	8,736
Iowa	17	190	141	15	26	600	12,324
Kansas	40	163	133	10	26	1,200	12,711
Kentucky	22	140	116	15	26	1,500	11,772
Louisiana	10	205	153	12	28	300	14,348
Maine	22	186	105	7	26	1,427	9,671
Maryland	25	153	120	26	26	900	5,508
Massachusetts	14	258	121	9	30	1,200	14,331
Michigan	41	197	158	13	26	2,010	15,085
Minnesota	30	191	141	11	26	1,724	14,171
Mississippi	30	105	86	13	26	1,200	8,187
Missouri	14	105	94	10	26	450	8,190
Montana	39	158	133	8	26	1,000	13,309
Nebraska	12	106	97	17	26	600	8,189
Nevada	16	149	119	11	26	563	11,619
New Hampshire	26	132	99	26	26	1,700	16,500
New Jersey	20	158	121	15	26	600	8,243
New Mexico	29	142	109	19	26	921	6,153
New York	25	125	100	26	26	800	4,980
North Carolina	15	166	108	13	26	1,368	12,948
North Dakota	47	175	134	12	26	1,880	13,391

TABLE 6 (cont.)
SELECTED BENEFIT AND ELIGIBILITY INFORMATION FOR REGULAR STATE UNEMPLOYMENT INSURANCE PROGRAMS, BY STATE, JANUARY 1983
(In dollars and weeks of benefits)

State	Weekly Benefit Min.	Max.	Avg.(b)	Duration Min.	Max.	Earnings Requirements Min.	Max.
Ohio	10	250	148	20	26	400	8,164
Oklahoma	16	197	145	20	26	1,000	15,363
Oregon	44	175	121	8	26	1,000	13,960
Pennsylvania	35	213	153	26	30	1,320	8,120
Puerto Rico	7	84	63	20	20	280	3,360
Rhode Island	37	174	112	12	26	1,340	11,684
South Carolina	21	118	95	14	26	900	9,201
South Dakota	28	129	108	18	26	1,568	10,059
Tennessee	20	110	90	13	26	800	8,577
Texas	27	168	132	14	26	1,013	16,174
Utah	10	166	133	10	26	1,200	12,012
Vermont	18	146	111	26	26	700	5,820
Virginia	44	138	113	12	26	2,200	13,800
Virgin Islands	15	124	94	26	26	396	3,720
Washington	49	178	136	16	30	1,237	16,019
West Virginia	18	211	142	28	28	1,150	20,750
Wisconsin	37	196	140	1	34	1,080	16,770
Wyoming	24	180	142	12	26	960	15,000

SOURCE: U.S. Department of Labor, Unemployment Insurance Service, Comparison of State Unemployment Insurance Laws (January 1983) and unpublished data.

a. For total unemployment; includes dependents' allowances.
b. October 1982 through December 1982.

When a state's unemployment exceeds a specified threshold, a provision of the 1970 Federal-State Unemployment Compensation Act is triggered which extends workers' UI benefit up to thirty nine weeks. To qualify for federal-state extended benefits, a worker must have exhausted his or her regular benefits, and have worked a minimum of 20 weeks in the base period that determines eligibility for the UI program. The threshold for triggering extended benefits is that the state's insured unemployment rate exceed 5% and be at least 20% higher than it was during the same period in the prior two years or that insured unemployment exceed 6% without the 20% provision. During fiscal 1984, about 1.3 million long term jobless persons will receive extended federal-state benefits accounting to $123 a week for an average of eleven weeks.

In addition, from time to time the federal government will authorize supplemental compensation to be paid from general revenues. For example, between September 1982 and September 1983, federal supplemental compensation was available for between eight to fourteen weeks to workers who had exhausted regular and federal state extended benefits. During 1983, an estimated 4 million workers received federal supplemental benefits averaging to $120 per week. In sum, total unemployment insurance outlays were $23.3 billion in 1982 and projected to be $29.1 billion in 1983. In 1984, approximately 10.9 million persons will receive regular UI benefits for an average of sixteen weeks. Compared to other unemployed persons who do not qualify for benefits, UI recipients on average tend to be older (average age of thirty six years for UI recipients, compared to thirty years for other unemployed persons), tend to work more in the year in which their unemployment occurred (thirty five compared to twenty four weeks), and are more likely to be male than female (62% compared to 52%). In addition, relatively more UI recipients previously worked in manufacturing and construction industries than other jobless workers and relatively fewer worked in retail trade and service industries.

The Productive Employment Program is proposed as a more efficient way of allocating unemployment insurance funds. The basic feature of the program is that a voucher would be substituted for the current weekly UI benefit. The recipient would be allowed to cash the voucher and receive the same payment as he or she now receives so under no circumstances would an unemployed worker be made worse off under the PEP program. Alternatively, the worker could give the voucher to an employer. The employer would then be eligible to receive some fraction of the worker's UI benefit over an extended period.

The precise form of the Productive Employment Program depends on the choice of several policy variables:

<u>Subsidy</u> The amount of the employment subsidy depends on the level of UI benefits to which the employee is entitled. We assume that UI benefits are some percentage of the average wage in an industry so the subsidy can also be expressed as a percentage of the average wage.

<u>Replacement Rate</u> We assume that the gross weekly subsidy is either 50%, 75%, or 100% of the employees' UI benefit, corresponding to replacement rates of 2.0, 1.5, and 1.0, respecively.

<u>Duration</u> Unemployment insurance benefits are usually paid over a 26 week (2 quarter) period. Employer subsidies would be paid over a 52 week (4 quarter) period. This would be accomplished by making the voucher consist of two coupons, one of which could be cashed immediately and the other redeemable twenty six weeks later if the employee was still on the company's payroll.

To discourage the churning of workers (i.e., firing current employees to hire new employees with the wage subsidy), we assume institutional regulations sufficient to guarantee a last hired/first fired behavior on the part of employers. This could easily be accomplished by deducting from the total subsidy payments due an employer the amount of new UI claims against that employer. Since the subsidy gained would be entirely offset by new UI claims, employers would have no incentive to layoff their current employees for new (and untried) workers carrying subsidies.

Several additional features of the program are included to prevent potential abuses of the subsidy program. These include:

(i) Any company with a turnover rate (number of exits/total number of employees) in excess of 3% would be banned from receiving new subsidies for a period of six months.

(ii) If a company was disqualified from receiving PEP payments twice in any two year period, the disqualification period would be extended to one year from six months.

(iii) Subsidies would be limited to a maximum of 10% of a company's work force at anytime.

(iv) An employer would not be allowed to receive a voucher from an employee it had terminated for a period of one year from the employer's termination.

None of these provisions substantially adds to the difficulty of administering the program, since all necessary information is now collected in connection with unemployment insurance and OASDI programs. In particular, the program is carefully constructed to avoid placing an undue administrative and record-keeping burden on employers that would discourage the hiring of workers with subsidies.

6. The Simulation Algorithm

The simulation of the PEP program proceeds in a series of steps. First, firms faced with given economic conditions choose employment levels consistent with the subsidy program. Increases in after tax wages above lost unemployment benefits for persons employed under the subsidy program contribute to disposable income. Changes in disposable income are transmitted into changes in personal consumption expenditure through a consumption function which relates current consumption through a distributed lag in disposable income. Changes in personal consumption are assumed to impact the economy in the next period above the baseline forecast for aggregate demand. New levels of output are determined for each industry by the input/output methodology and the realized average wage is calculated. These steps are now outlined in more detail.

6.1 Startup and Monitoring of PEP

The simulation of the PEP program is assumed to begin in the first quarter of 1984. Labor demand, aggregate demand and all other variables are known in this period. A first step is then taken to forecast industry output for the next quarter. This forecast assumes that there is no change in personal consumption expenditure above baseline levels.

At each step in the simulation, we determine the number of individuals hired onto the subsidy program. It is not sufficient to calculate total employment on subsidy; rather we need to know when individuals were hired. To accomplish this task of monitoring, we set-up a matrix for individuals hired to the subsidy program in each period. This matrix is illustrated below:

<u>Simulation Matrix</u>

82:4	83:1	83:2	83:3	83:4	84:1	84:2	84:3	84:4	85:1	85:2	85:3	85:4	86:1	86:2	
0	0	0	0	0	O_5	O_6	O_7	O_8	O_9	O_{10}	O_{11}	O_{12}	O_{13}	O_{14}	new hires to subsidy program
E_0	E_1	E_2	E_3	E_4	E_5	E_6	E_7	E_8	E_9	E_{10}	E_{11}	E_{12}	E_{13}	E_{14}	cumulative labor off subsidy

Given output levels determined by the input/output analysis, average wages and employment levels may be calculated. The next section develops this construction.

6.2 <u>Calculation of Average Wage and Realized Wage Bill</u>

Given a level of employment, and an existing wage bill, firms are assumed to respond to the available subsidy so that employment and average wages are consistently determined. We begin with a simplified specification of the estimated labor demand equation:

$$\log L_t = \alpha \log W_t + \log K_t \tag{6.1}$$

where L_t = labor demand, W_t = nominal wage and K_t = all other predetermined factors at period t. The wage bill in period t is determined by last period's wage bill, plus the cost of new hires at the subsidized wage, plus an adjustment for the increased expense of workers currently employed on subsidy who were hired four periods ago:

$$W_t L_t = W_{t-1}L_{t-1} + (w - S)(L_t - L_{t-1}) + O_{t-4} \cdot S \tag{6.2}$$

where W = wage rate in absence of PEP program, S = subsidy, and O_t = number of employees hired on the subsidy in period t.

We rewrite Equation (6.2) as:

$$(W_t - (w - S))L_t = (W_{t-1} - (w - S))L_{t-1} + O_{t-4} \cdot S \tag{6.3}$$

Taking logs we have:

$$\log(W_t - (w - S)) + \log L_t = \log C_t \quad \text{where:} \tag{6.4}$$

$$C_t = (W_{t-1} - (w - S))L_{t-1} + O_{t-4} \cdot S \tag{6.5}$$

Substituting Equation (6.1) we find:

$$\log(W_t - (w - s)) + \alpha \log W_t + \log K_t = \log C_t \quad \text{or} \tag{6.6}$$

$$(W_t - (w - s))W_t^{\alpha} = C_t/K_t \quad \text{which implies:} \tag{6.7}$$

$$h(W_t) \equiv W_t^{\alpha+1} - (w - s)W_t^{\alpha} - C_t/K_t = 0 \tag{6.8}$$

Equation (6.8) does not have a simple closed form solution for W_t. However it is possible to solve (6.8) using a simple iterative technique. Note first that $h'(W_t) = (\alpha + 1)W_t^{\alpha} - (w - s)\alpha W_t^{\alpha}/W_t$ $= W_t^{\alpha}((\alpha + 1) - (w - s)\alpha/W_t)$ which is necessarily positive as $w \leq s$ and $-1 < \alpha < 0$ (α = short-run labor elasticity). The second derivative $h''(W_t) = \alpha(\alpha + 1)W_t^{\alpha-1} - (\alpha - 1)\alpha(w - s)W_t^{\alpha-1}/W_t$ $= W_t^{\alpha-1}(\alpha(\alpha + 1) - (\alpha - 1)\alpha\,(w - s)/W_t) < 0$. Furthermore $\lim_{h_t \to +\infty} h(W_t) > 0$ and $\lim_{W_t \to 0} h(W_t) < 0$. Hence $h(W_t)$ is a concave function which has a unique root.

We use W_{t-1} as a starting value in calculating W_t. If $h(W_{t-1}) < 0$, the solution for W_t implies $W_t > W_{t-1}$. It then follows that $L_t < L_{t-1}$ so that desired demand falls. In this case, we assume that desired demand is inconsistent with the subsidy program and therefore equation (6.2) is incorrect. Instead we set $W_t = W_{t-1}$ and proceed. If $h(W_{t-1}) > 0$ we attempt to bound the solution by a lower trial wage of $(0.75)W_{t-1}$. If h is negative at the lower trial wage, then we have bounded the root and solve iteratively for the solution by a method of interval splitting.

If h were positive at the lower trial wage, the lower trial wage would have to be set lower. In our analysis, a lower trial wage of $(.75)W_{t-1}$ yielded negative h. The iterative technique proved both precise and fast in solving for W_t. There are now three cases to consider:

Case 1 (Positive Hiring to Subsidy Program)

Average wages and labor demand are determined so that incremental labor demand is positive $(L_t - L_{t-1}) > 0$. In this case the new hiring is entered onto the upper row of the simulation matrix: $O_t = L_t - L_{t-1}$. As the number of employees off subsidy has not changed, the employment level is maintained into the next period $E_t = E_{t-1}$.

Case 2 (Firing from the Subsidy)

Average wages and labor demand are determined so that the incremental demand for labor is negative $(L_t - L_{t-1}) < 0$. In this case we employ a rule of last hired/first fired. We then begin a simple search through the cells in the simulation matrix, removing from the subsidy rolls any individuals who need to fired. Thus in each interation the simulation matrix is updated to reflect both current and past conditions. If L_t is significantly less than L_{t-1}, it may be necessary to remove all individuals from the subsidy program (setting $O_1, \ldots, O_t = 0$) and to remove the remaining individuals from the off subsidy payroll.

Recall that the last-fired/first-hired rule reflects a feature of the PEP program designed to reduce the effects of "churning." Labor market churning is assumed to occur when expensive labor is fired so that inexpensive labor may be hired in its place.

Case 3 (Transfer of individuals from Subsidy to Off Subsidy)

After an individual has been on the subsidy program for a number of periods given by the length of the program, he or she becomes ineligible for continued support and is necessarily transferred to the off subsidy group. At this point E_t is changed to $E_t + O_{t-\ell}$ where ℓ = length of the subsidy program and $O_{t-\ell}$ is set to zero. Note that the effect of labor transfer is also anticipated when average wages are calculated.

At the end of each iteration we recalculate the total wage bill for the firm. Total wages in period t are the sum of wages paid to the employees off subsidy and the wages paid (at their subsidized rates) to the total number of employees on the subsidy program.

6.5 Change in Personal Consumption Expenditure

Once the industry hiring levels have been determined, we calculate the change in personal consumption expenditures under the policy versus those under a null simulation with no wage subsidies. The increase in the private sector wagebill under the policy increases personal disposable income and, hence, available funds for personal consumption, while any decrease in UI payments will tend to decrease consumption. All computations are net of taxes, in view of the tax exemption of UI benefits. The computation of the null simulation and change in personal consumption expenditure is discussed in greater detail below.

The null simulation is very easy to perform. Industry wages are fixed at their final period (1983:4) values and labor demand is calculated each period using a forecast of the industrial production index based on the input/output model described in Section 4. The baseline forecasts are those of the American Statistical Association/National Bureau of Economic Research Business Outlook Survey which are assumed to reflect all aspects of macroeconomic activity independent of the proposed policy. Alternatively, some other set of macroeconomic forecasts can be substituted for the ASA/NBER forecasts to produce a different null simulation and then the performance of the policy can be evaluated under these macroeconomic conditions. A more pessimistic macroeconomic scenario than that foreseen by the ASA/NBER forecasters is reported in Table 5, in addition to the consensus ASA/NBER forecast reported in Table 4.

To calculate the change in personal consumption expenditure with a wage subsidy over the null simulation, the private wage bill is calculated for a period. Next, the total change in personal disposable income over the null simulation is calculated. Third, a dynamic consumption function is applied to the excess personal income

to determine the change in personal consumption expenditure. This change is finally used to augment the ASA/NBER forecast of personal consumption expenditure, and the input-analysis is performed to determine new levels of industrial production.

For an individual hired on the subsidy, who would not otherwise have been employed, we calculate disposable personal income as follows:

(1) From their new employer they receive a wage W_t, which is taxed at a rate τ.

(2) During the first two periods of their employment, they would have otherwise been entitled to an unemployment insurance benefit RS, where S denotes the wage subsidy and R is the replacement rate (the ratio of unemployment insurance benefits to subsidy payments). The unemployment insurance benefit is not taxable so the entire amount is deducted from their disposable income.

Once the change in disposable income has been calculated, we apply an aggregate consumption function to determine the change in personal consumption expenditure, ΔPCE with results from a change in personal disposable income, ΔPDI. Using results in Fair (1984), we assume a consumption fraction:

$$\Delta PCE_t = 0.47\Delta PDI_t + 0.27\Delta PDI_{t-1} + 0.16\Delta PDI_{t-2} \quad (6.9)$$

$$+ 0.10\Delta PDI_{t-3} \quad (6.10)$$

This formulation implies that consumers spread their spending over the course of a year. The change in personal disposable income is given by:

$$\Delta PDI_{t-k} = [(1 - \tau)w - RS][L_{t-k} - L^0_{t-k}] \quad (6.11)$$

for $k = 0,1$ where L^0 denotes man hours worked under the null simulation. For $k = 2,3$, we have:

$$\Delta PDI_{t-k} = (1 - \tau)w[L_{t-k} - L^0_{t-k}] \tag{6.12}$$

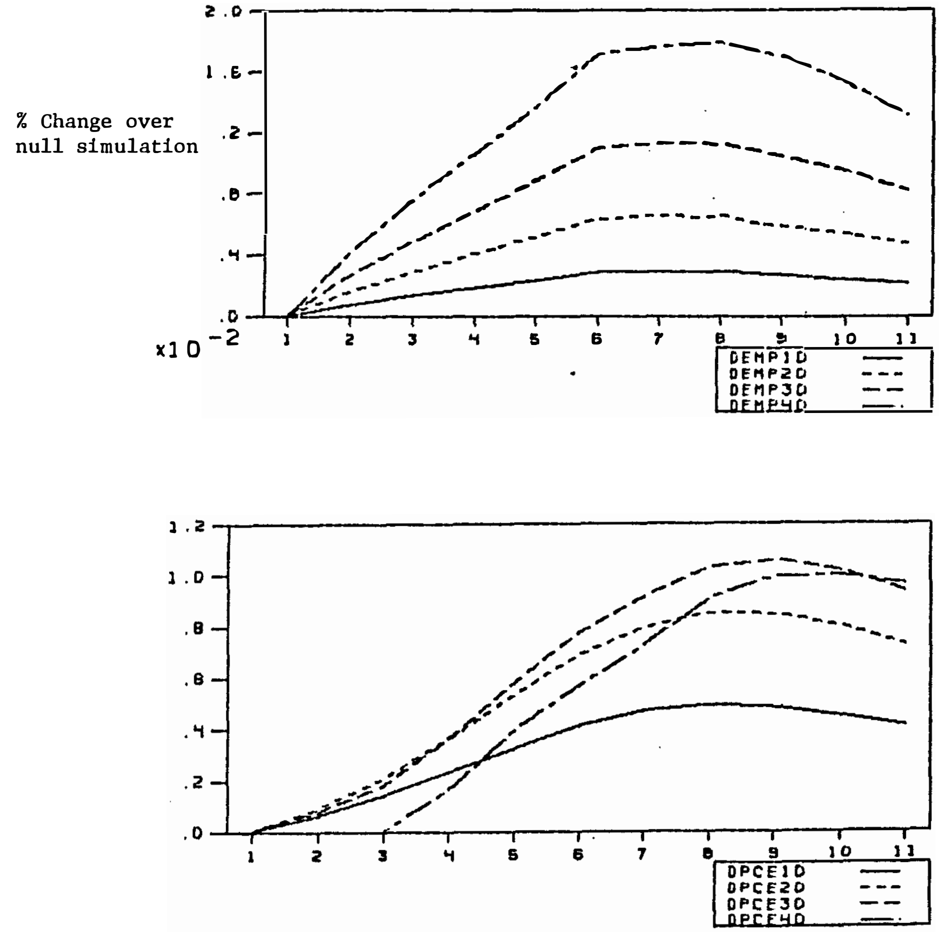
since persons hired two periods ago would have exhausted their unemployment insurance benefits.

7. SIMULATION RESULTS

The simulations reported below indicate the magnitude of benefits and costs derived from the Productive Employment Program under a variety of assumptions about the level of the wage subsidy, the unemployment insurance replacement rate, and prevailing macroeconomic conditions. Information is provided on the increase in employment due to the wage subsidy, the number of persons who would be receiving subsidy payments over the course of the program, changes in personal consumption expenditures, and detailed revenue effects. First, we summarize the macroeconomic consequences of the program under a variety of assumptions and then, for a particular simulation, describe the industry by industry effects.

Figure 3 illustrates a series of simulations assuming a replacement rate of 2.0, i.e., an employer can collect a subsidy equal to 50% of the employees UI compensation over a period of four quarters, instead of the two quarters of compensation to which the unemployed worker is normally entitled. A 10% subsidy is shown to have a quite modest impact with only an 0.2% longrun increase in employment levels. For larger subsidies--in the 20% to 30% range--the effects are more substantial: the PEP program would reduce longrun unemployment by between 0.5% and 1.0%. These subsidy levels are in line with existing levels of UI benefits. For example, in an industry with an average wage of $8/hour, 50% of a $160/week UI payment is equivalent to a 25% wage subsidy. If the subsidy payment is increased to 40% of prevailing industry wages, then the employment effects of the PEP program are very substantial: over 1.8% increases in employment at the peak period. Whether such funding levels are possible depends on the availability of additional funds to supplement existing UI benefits.

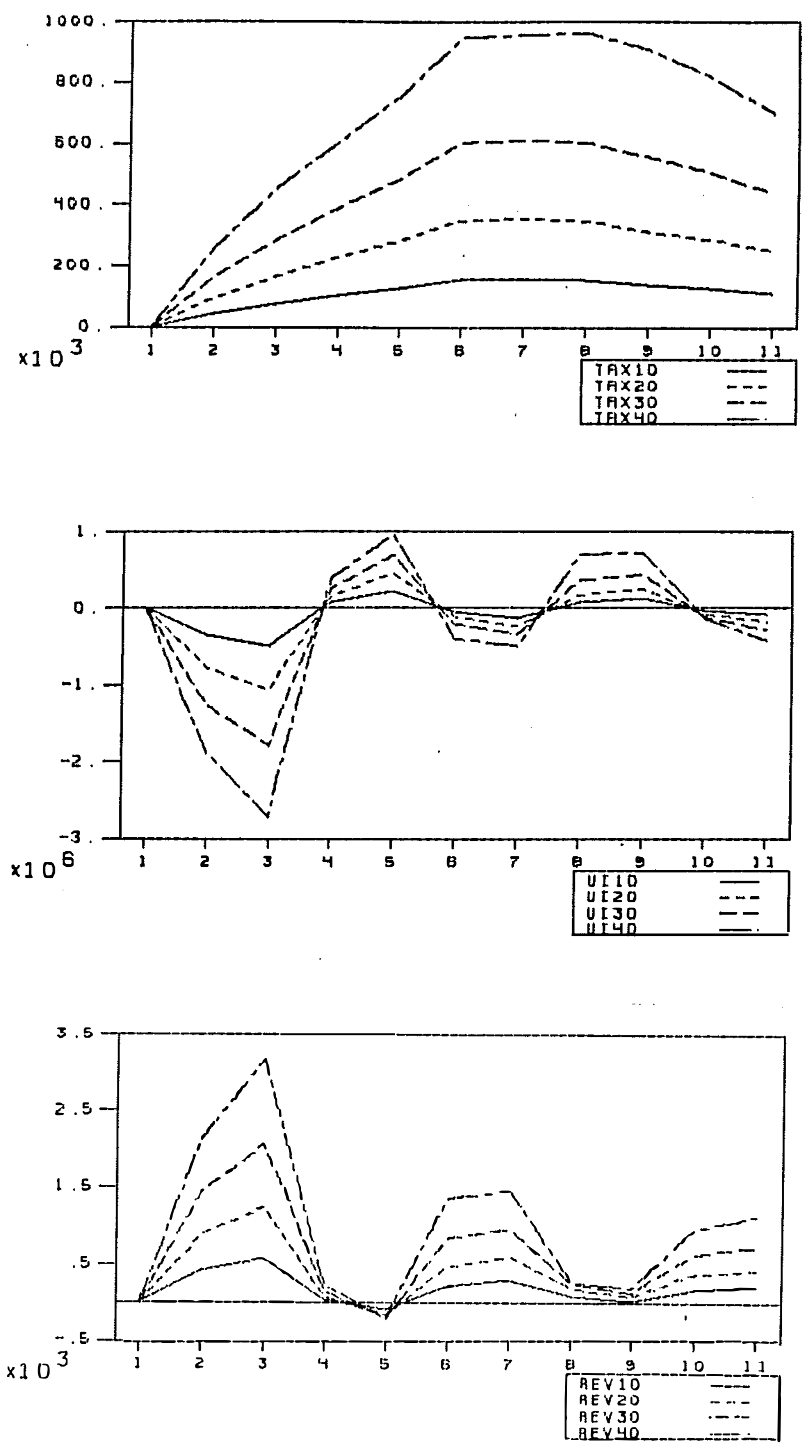
FIGURE 3



AGGREGATE SIMULATION RESULTS USING NBER CONSENSUS FORECAST AND 2.0 REPLACEMENT RATE

KEY: All amounts (except employment data) measured in billions of dollars per quarter. Period 1 is 1983:4. Periods 2-11 are simulated values.

FIGURE 3 (cont.)



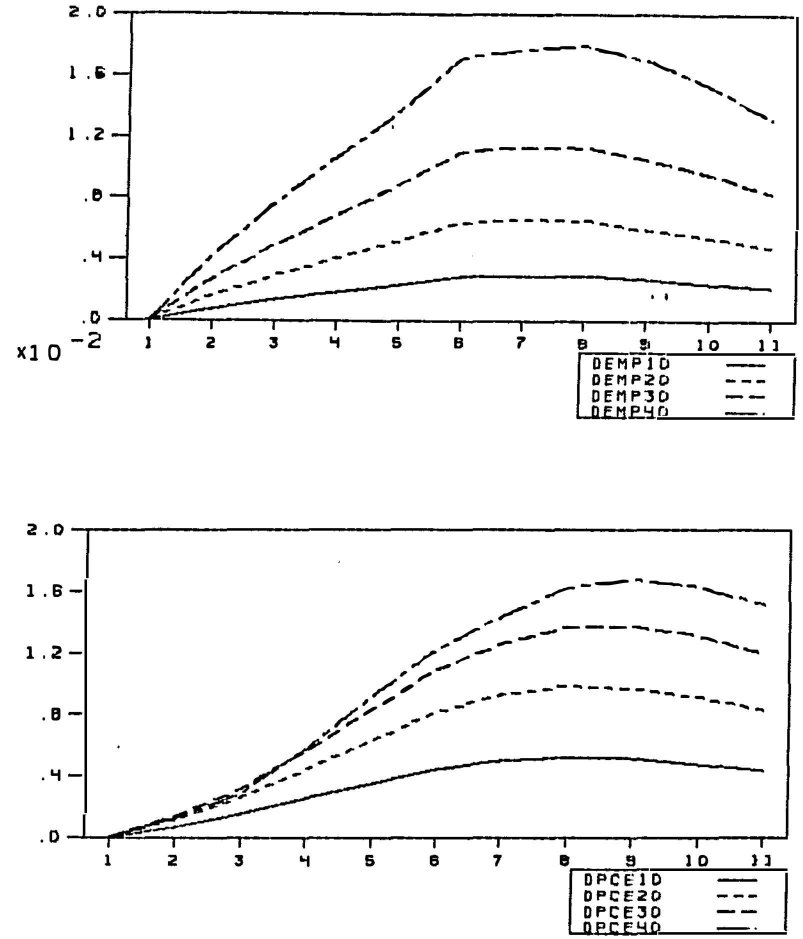
Increases in employment occur steadily over the first five to six periods of the program and then employment levels off or even falls slightly from its peak level. Changes in personal consumption expenditure occur more slowly, but, after two years of the program, the expansion in employment has increased consumer spending by over $1 billion per quarter. This increase in spending is evidently sufficient to permanently sustain the increased employment levels. Contrary to the usual criticism of wage subsidies, that subsidies only create temporary employment opportunities, an economy wide implementation of the PEP program appears to allow a permanent decrease in unemployment. It should be noted, of course, that a limited implementation of the program (e.g., one restricted to a few industries or a small subset of the insured unemployed population) would not provide these benefits to the economy.

We have also calculated the revenue effect of varying levels of the wage subsidy. First, increases in employment lead to higher tax revenues. Based on a 20% tax rate for the target population, a 20% subsidy increases revenue by about $300 million per quarter while a 30% subsidy increases revenue, during peak periods, by over $500 million per quarter. Another beneficial revenue effect of the program is to initially decrease UI compensation, since payments to employers are being spread over four quarters rather than the two quarters in which individuals would be entitled to receive them. Of course, subsidy expenses exceed baseline UI costs in later periods, but overall the PEP program has positive revenue effects.

Another set of simulations was performed assuming a replacement rate of 1.0, i.e., employers would be entitled to receive the full amount of a worker's weekly UI benefit over twice the normal period. This treatment of PEP payments increases the cost of the program, since increases in tax revenues are insufficient to cover increased UI outlays. The employment and spending effects of a 1.0 replacement rate are similar to those in the 20 replacement rate simulations reported before, except for the highest subsidy level (40%).

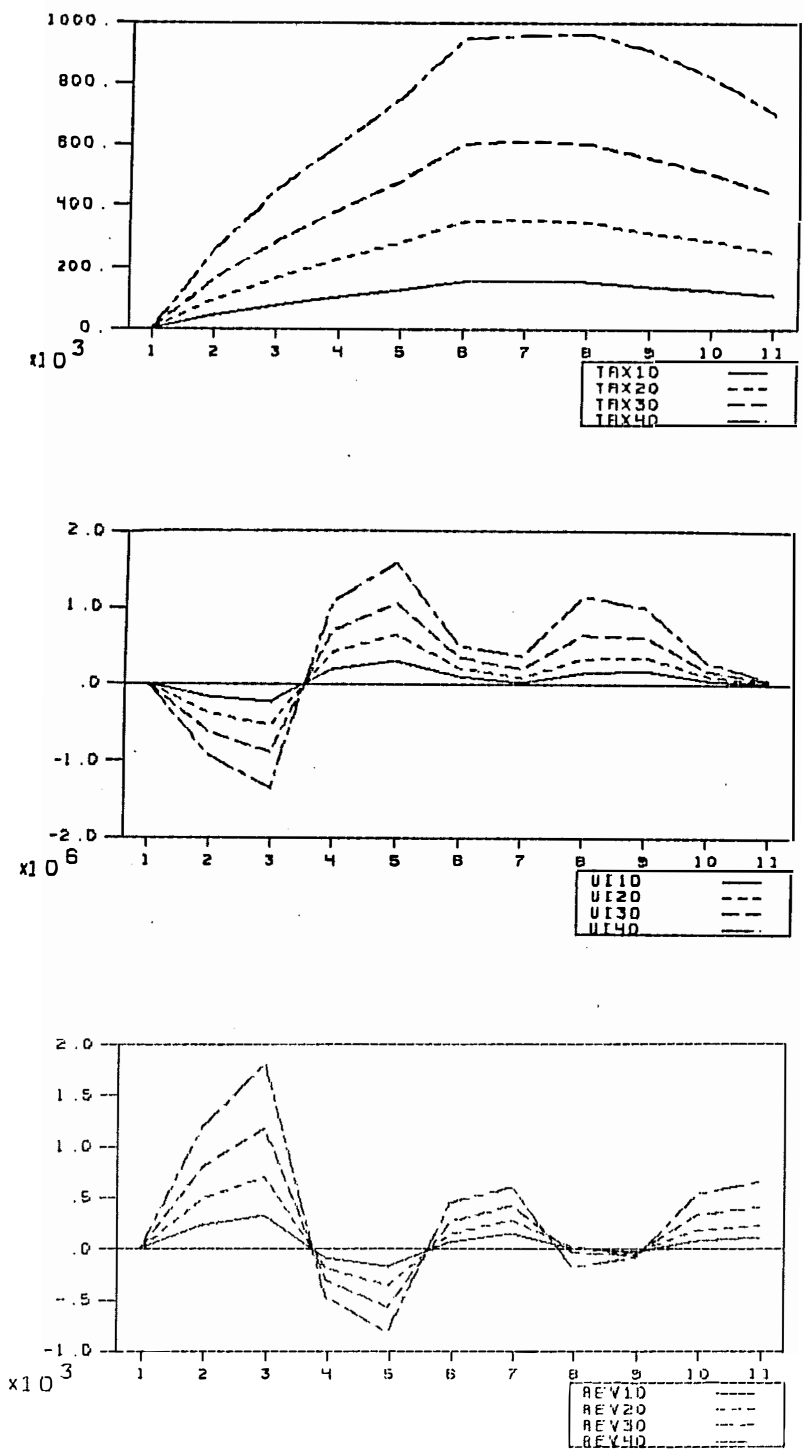
The next set of simulations (Figure 4) is based on an intermediate replacement rate of 1.5, i.e., employers would receive 75% of the worker's weekly UI benefit. This change reduces the cost of the PEP program, while making a larger subsidy (30% to 40% of industry wages) possible. Again, employment and spending effects resemble those in earlier simulations, with the exact magnitudes depending on the level of the subsidy. The overall revenue effect is still negative, but much less so than for the 2.0 replacement rate simulation. If welfare expenditures and other implicit costs of unemployment were credited to the PEP program, then it might be possible to fund a 30% to 40% subsidy at a 1.5 replacement rate without adverse revenue consequences.

FIGURE 4



AGGREGATE SIMULATION RESULTS USING NBER
CONSENSUS FORECASTS AND 1.5 REPLACEMENT RATE

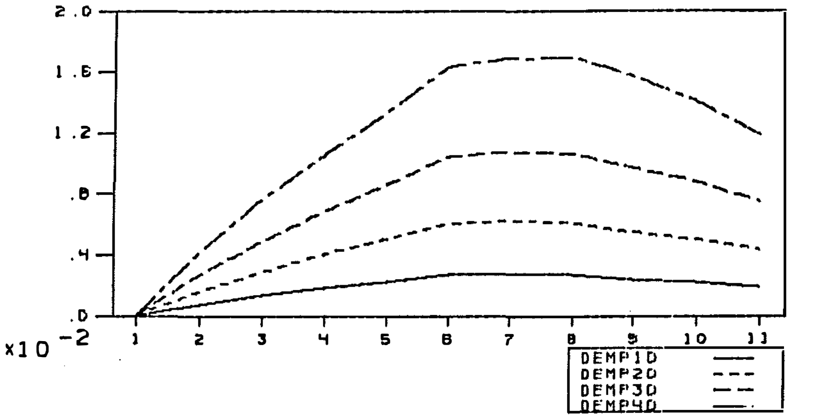
FIGURE 4 (cont.)

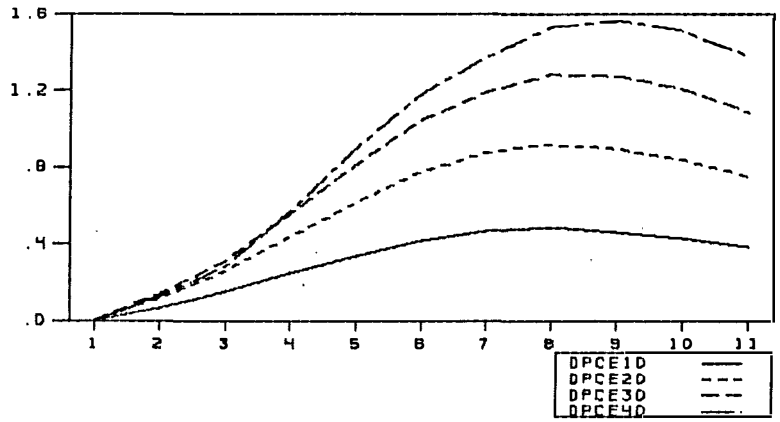


The final set of simulations (Figure 5) are conducted under a pessimistic macroeconomic forecast to evaluate the countercyclical performance of the PEP program. (A replacement rate of 1.5 was assumed.) As might be expected, the program is less effective in a recessionary environment, but the overall effect is still countercylical. Employment and spending effects are reduced approximately 10% compared to those in simulations using the ASA/NBER forecasts, while costs remain roughly constant.

Next, we turn to an industry by industry analysis of the PEP program's effects. These simulations are based on a subsidy of 30% with a replacement rate of 2.0. For selected industries, Figure 6 plots employment levels with the subsidy versus those under the null simulation as well as the number of employees receiving subsidies during each period. Several features of the PEP program can be gleaned from the specific industry results. First, which industries benefit most or least (or don't participate at all) in the program can be learned. Second, the possibility of churning can be analyzed. There is little possibility of churning when the number of workers on subsidy is increasing, due to the implied hiring practices of firms which prevent replacement of existing workers by those on subsidy. However, the number of workers receiving subsidies on a firm's payroll can fall for reasons other than churning. For example, workers lose their subsidies after four quarters may remain on a firms payroll. In fact, churning occurs only when a firm decreases its overall level of employment after hiring worker on subsidy, so churning can be detected by comparing overall employment levels with the pattern of subsidized hires.

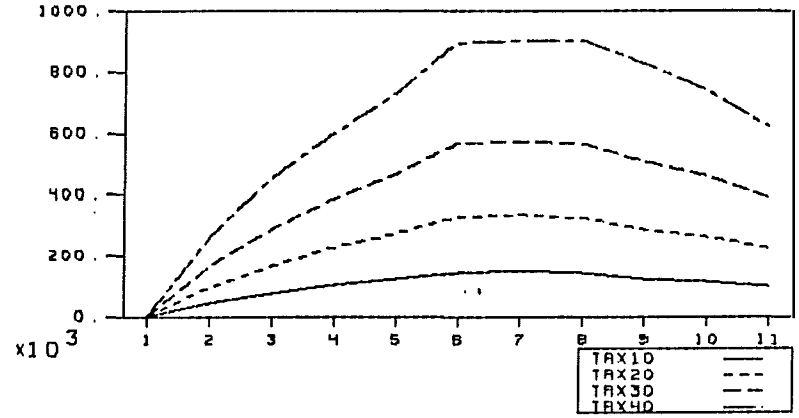
FIGURE 5

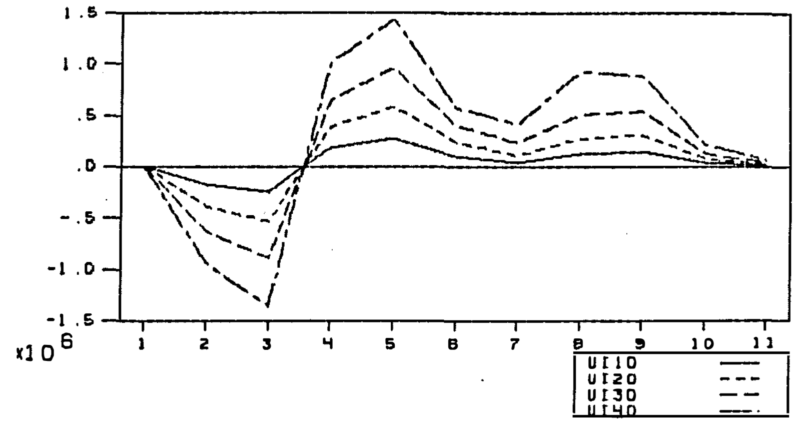


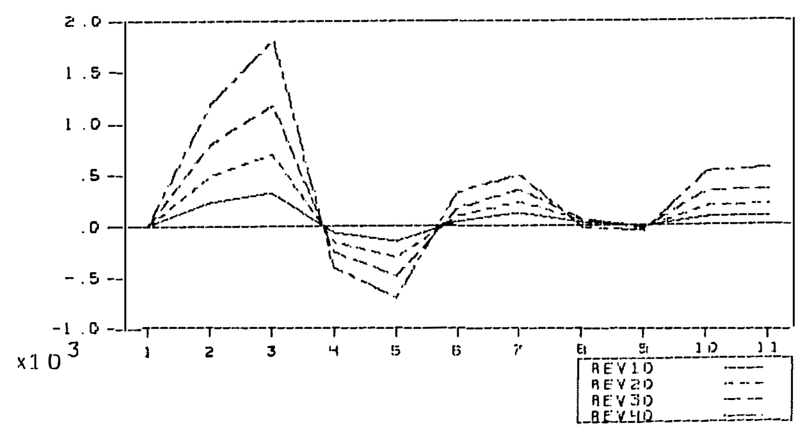


AGGREGATE SIMULATION RESULTS USING PESSIMISTIC
FORECAST AND 1.5 REPLACEMENT RATE

FIGURE 5 (cont.)







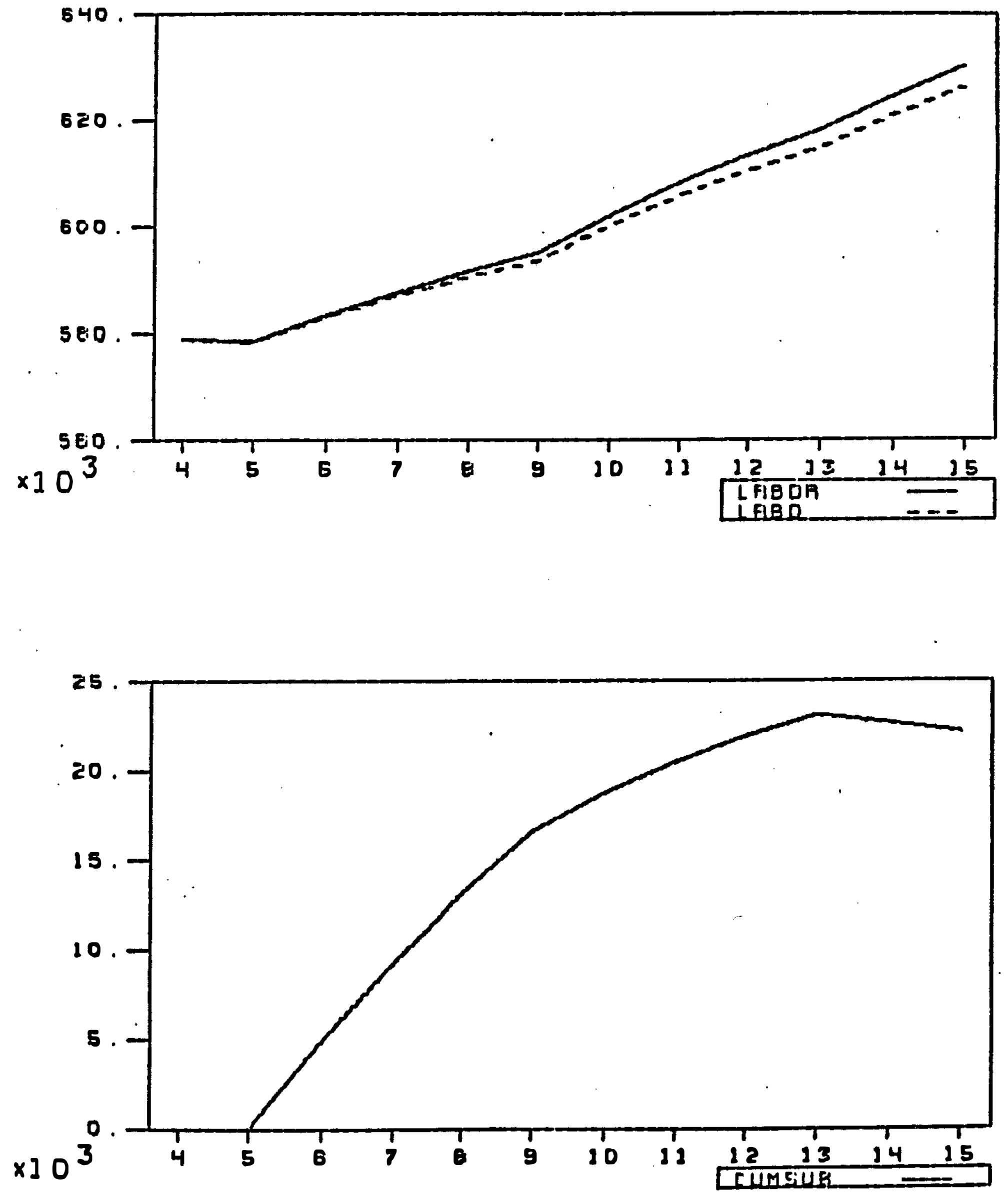
A few industries do not participate in the program in any substantial way: mining, textile mill products, furniture and fixtures, printing and publishing, petroleum, leather products, finance and real estate. Durable manufacturing industries appear to be the heaviest users of the subsidy programs (chemicals, fabricated metals, electrical machinery, transportation equipment, as well as building materials and paper). In a few cases, employment in these industries increases by 5% or more.

In 17 of the 26 industries, it is apparent that no churning occurs. Industries which normally exhibit cyclical behavior (such as construction, building materials, transportation equipment and services) are potential candidates for churning, but unless the industry exhibits a steady decline, some workers hired on subsidy are able to achieve permanent employment when their subsidy runs out. We estimate that about 80% of all workers hired on subsidy achieve permanent employment. Overall, any inefficiency in the allocation of employment by the PEP program seems quite modest, particularly in comparison with other labor market policies, and is offset by permanent increases in employment induced by the program.

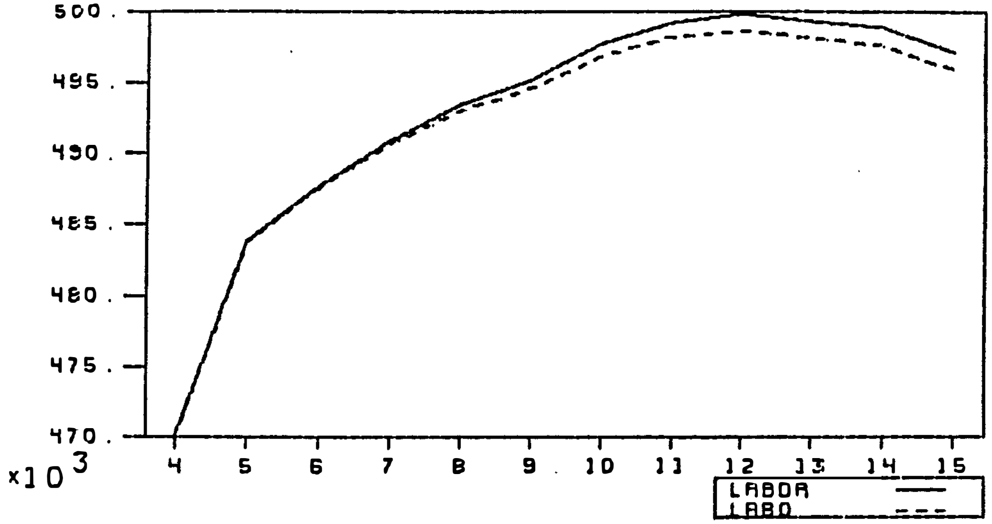
FIGURE 6

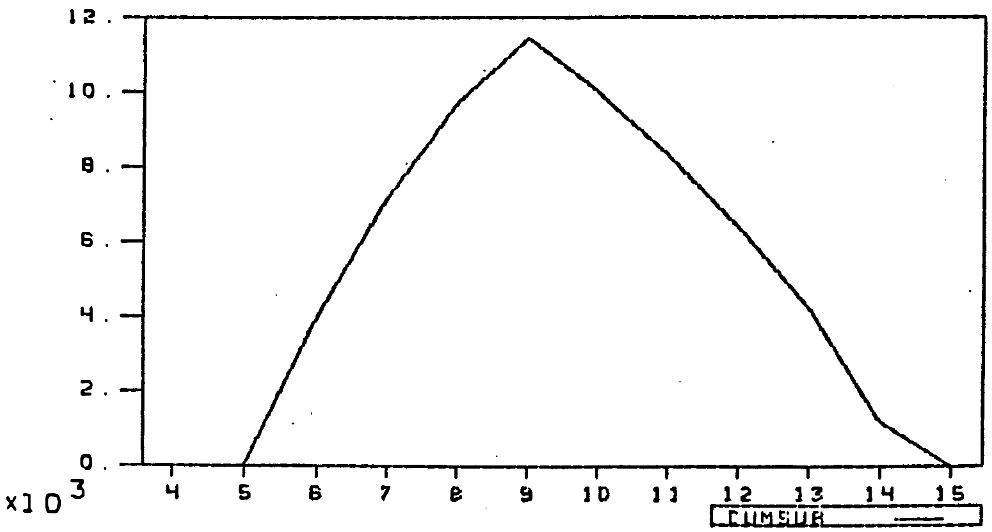
SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT

(FOOD & KINDRED PRODUCTS)

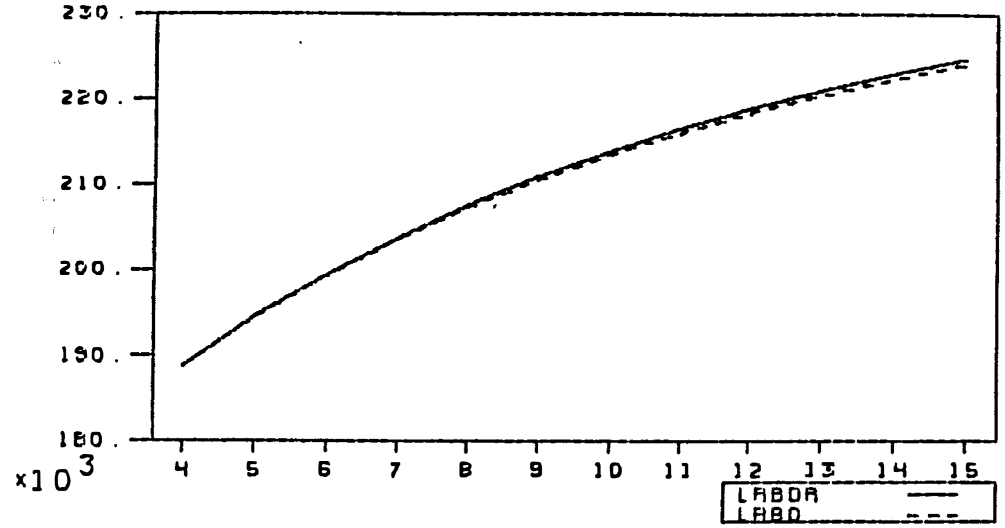


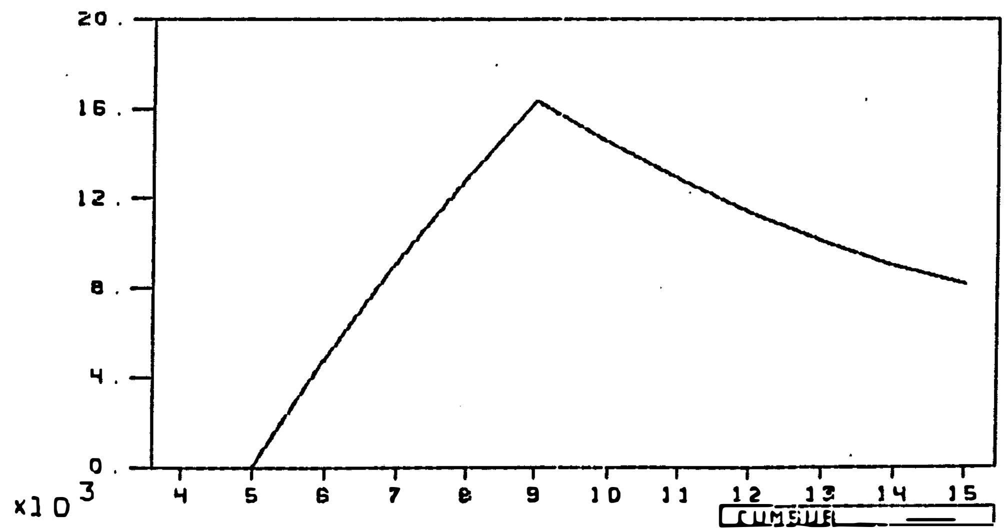
SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT
(APPAREL & OTHER TEXTILES)





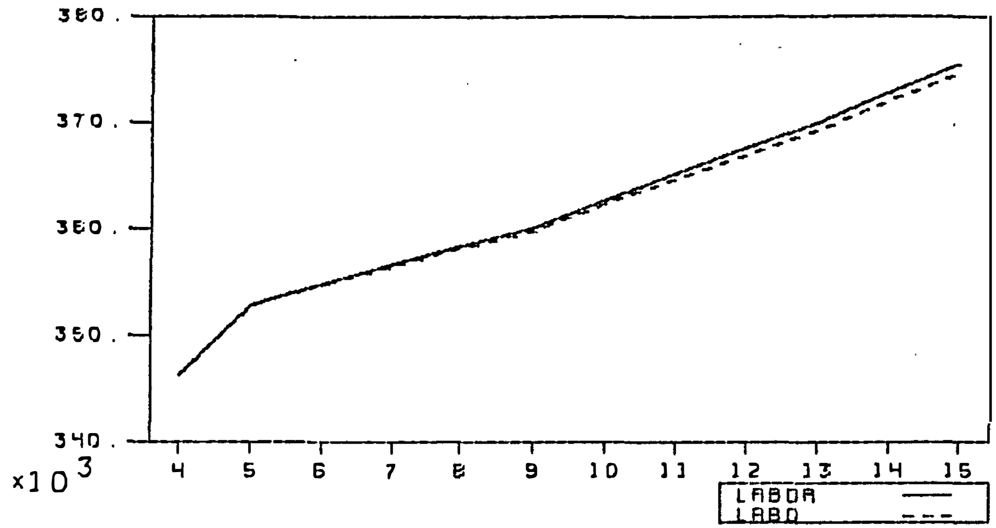
SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT
(FURNITURE & FIXTURES)

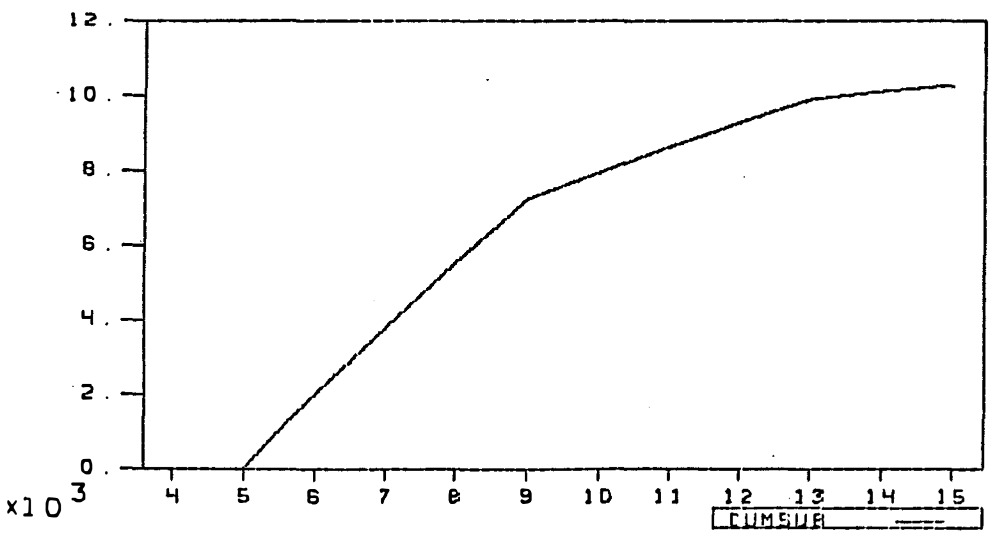




SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT

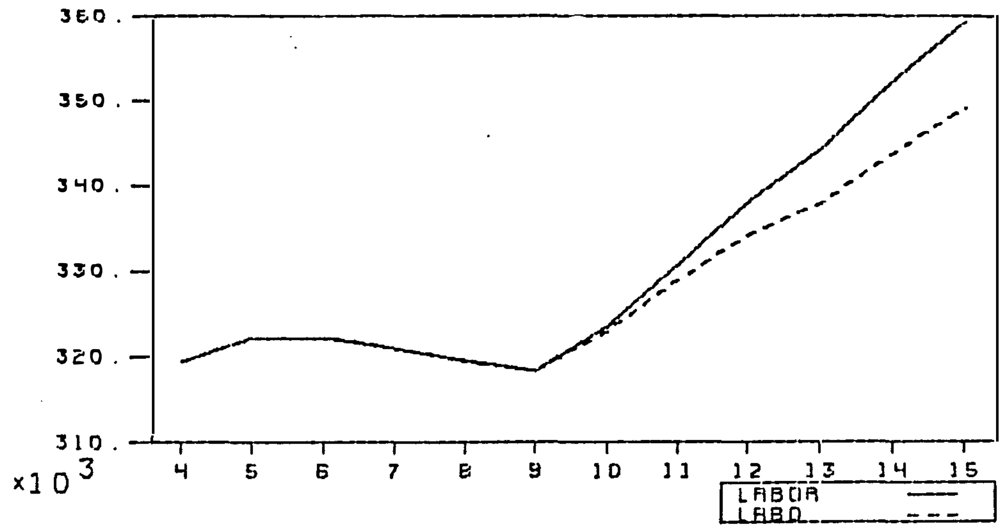
(PRINTING & PUBLISHING)

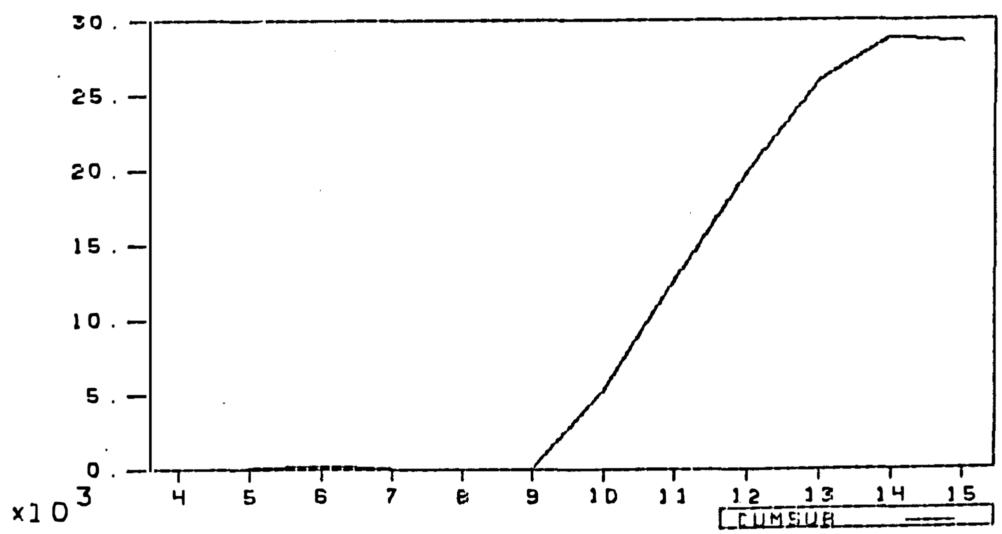




SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT

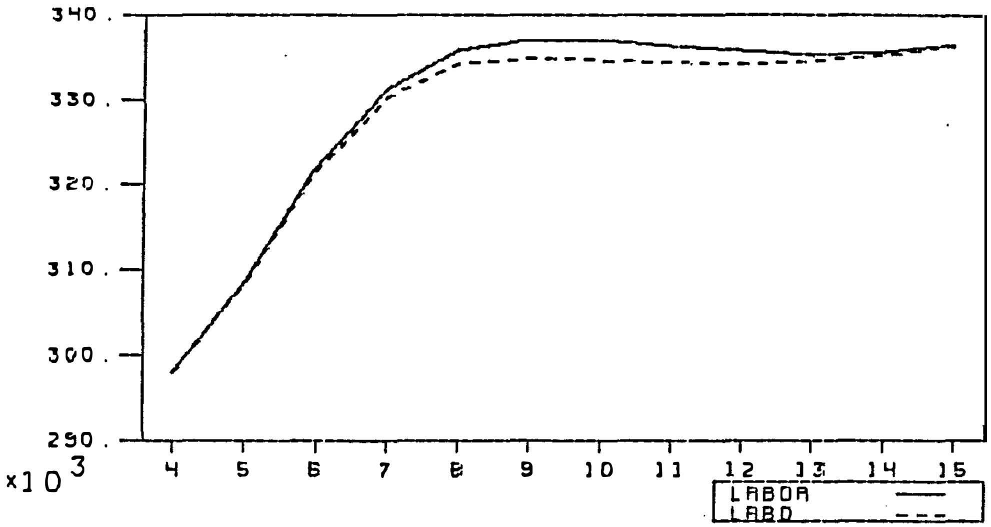
(CHEMICAL & ALLIED PRODUCTS)

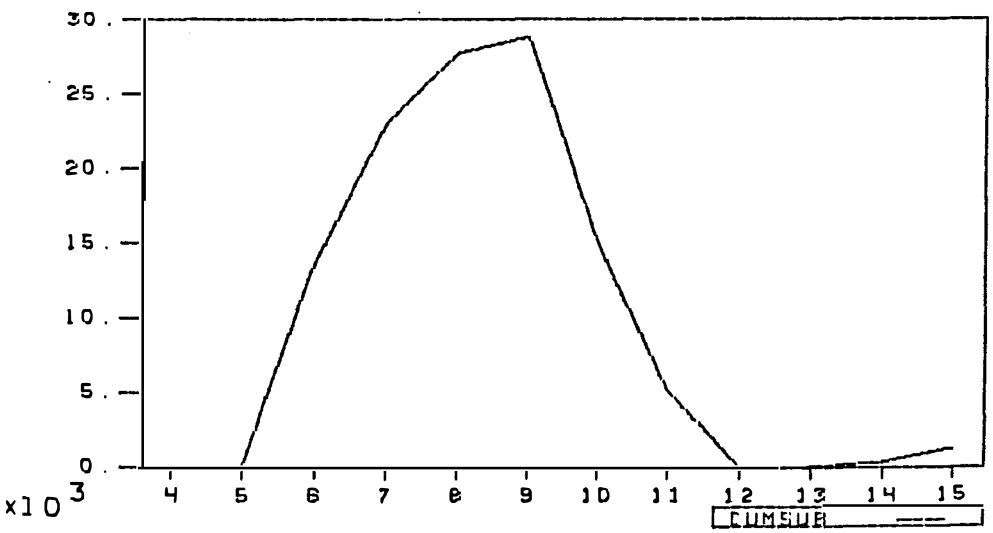




SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT

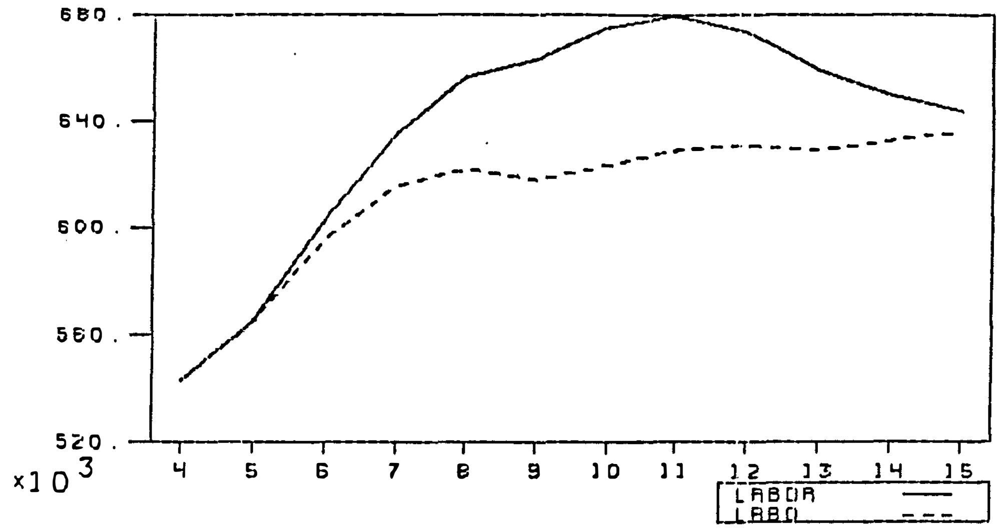
(RUBBER & PLASTICS PRODUCTS)

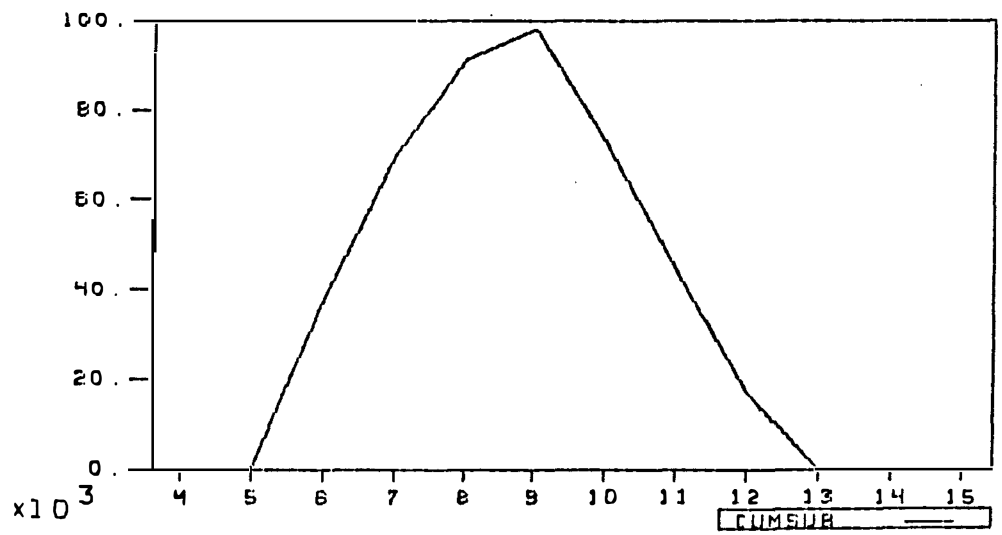




SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT

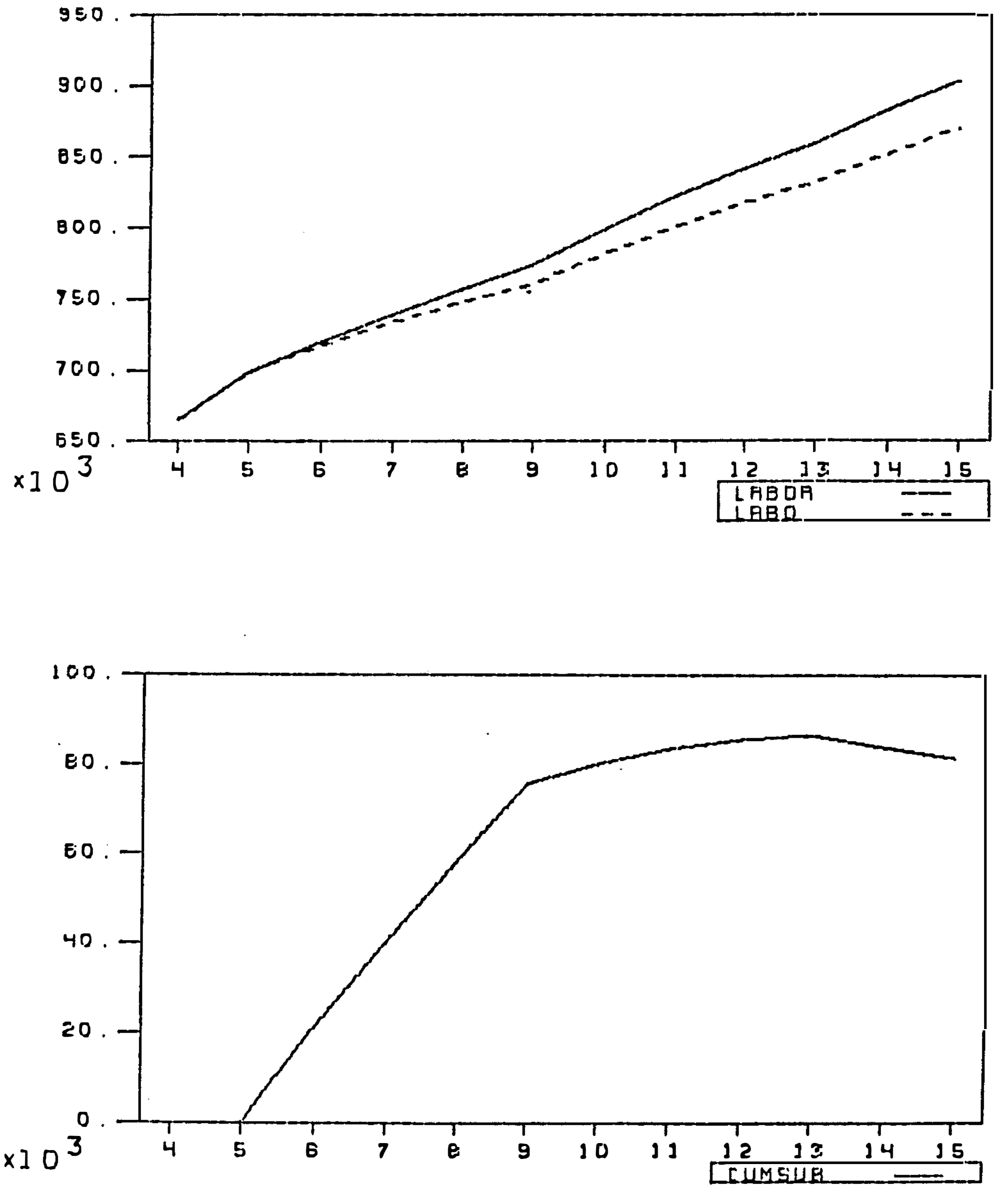
(FABRICATED METALS)





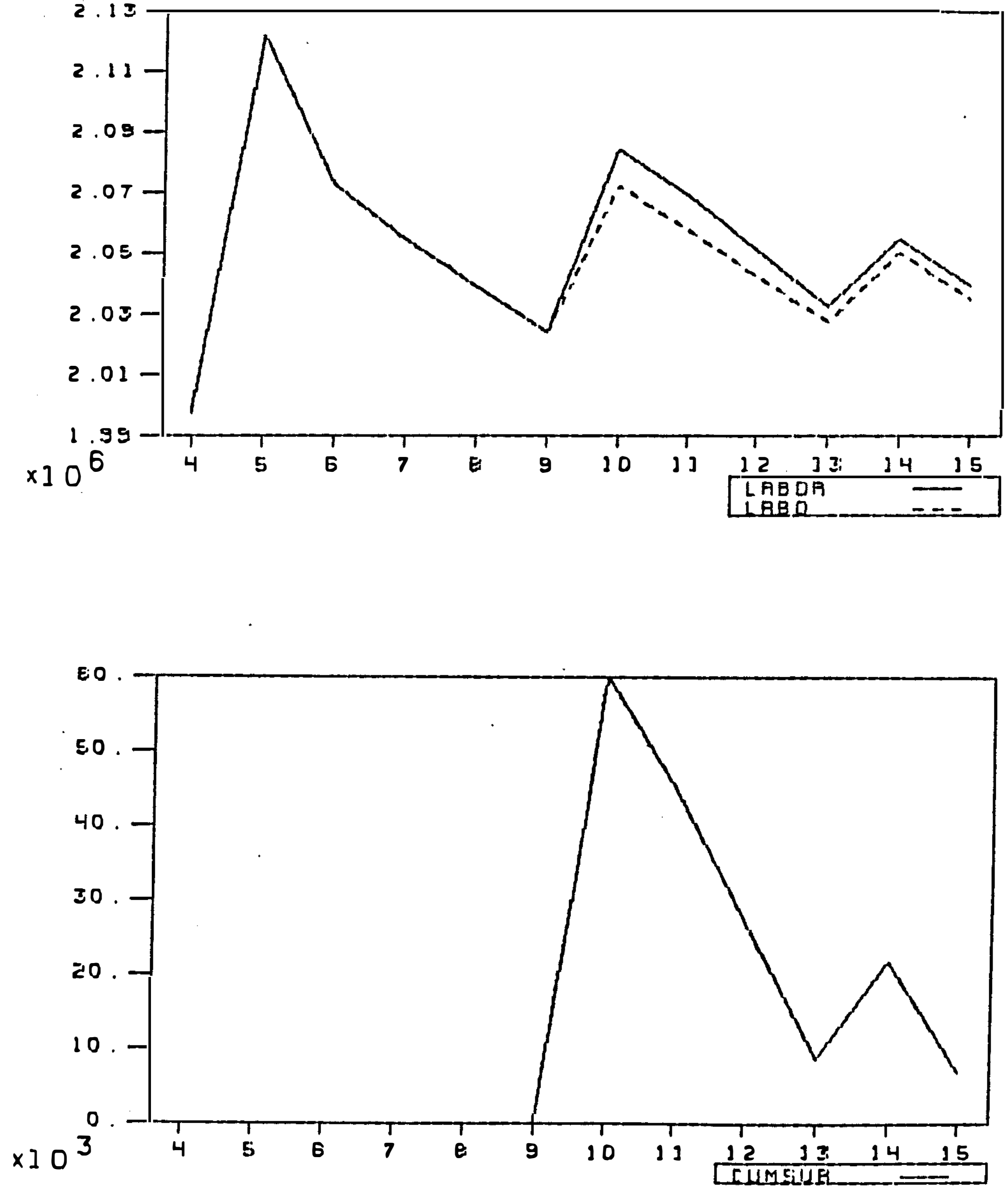
SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT

(ELECTRICAL MACHINERY)



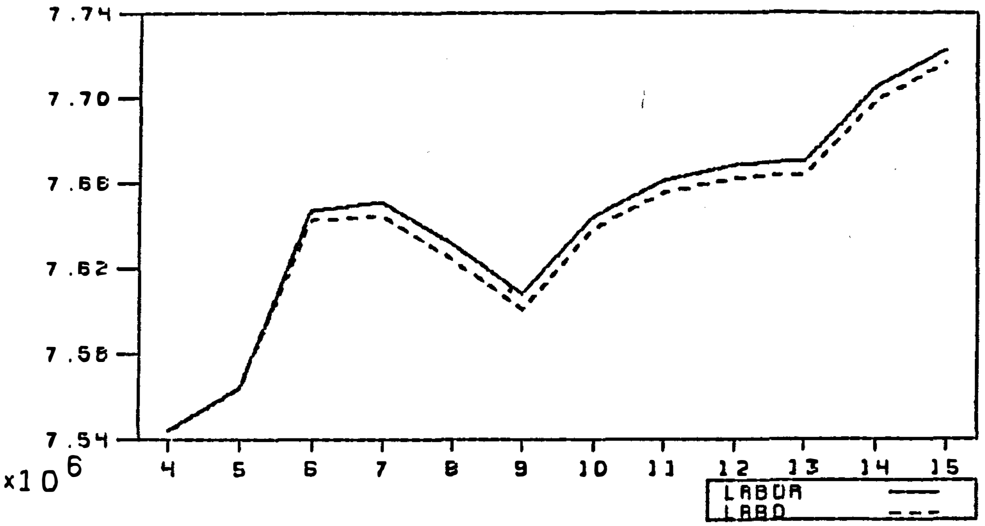
SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT

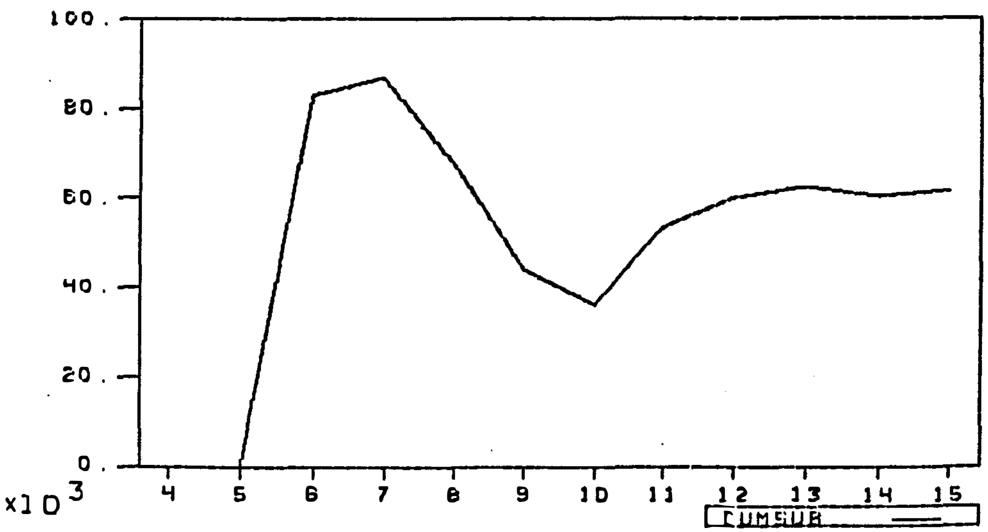
(TRANSPORTATION AND UTILITIES)



SIMULATED LABOR DEMAND AND SUBSIDIZED EMPLOYMENT

(TRADE WHOLESALE AND RETAIL)





8. Conclusions

Our initial evaluation of the PEP program is positive. A subsidy equivalent to 20% to 30% of prevailing industry wages is predicted to reduce insured unemployment by about 1% over six to eight quarters. Moreover, the employment induced by the program increases consumer spending sufficiently to sustain higher levels of employment on a permanent basis. The program as described also does not require any additional federal spending beyond what has already been authorized under the current UI program and, in fact, has an overall favorable fiscal impact.

The strategy of incorporating macroeconomic feedback effects into a labor market model via an input/output model provided very satisfactory results. While this approach is not generally applicable—since the assumptions imposed on prices and wages would be less appropriate for other purposes--for a wide variety of situations it seems preferable to the alternative of constructing a full scale macroeconometric model. The input/output approach allows industry models to incorporate sufficient detail for analysis of specific policies and to include macroeconomic feedback effects as well. In a large scale macroeconomic model, policy analysis is usually severely hindered by the absence of variables in the model directly affected by the policy in question. The input/output approach, of course, allows less flexibility in the modeling of macroeconomic effects, but in evaluating alternative policies this sacrifice is well justified.

APPENDIX A: DEFINITION OF VARIABLES IN LABOR DEMAND MODELS

C.1. Number of Workers

Source: U.S. Department of Labor, Bureau of Labor Statistics. The employment estimates are for all fifty states and the District of Columbia. The data cover all production and related workers and include full time and part time workers who are on payrolls of private non-agricultural establishments and who received pay for all or any part of the pay period. Not counted are persons who are layed off, on leave without pay, or on strike for the entire period. The manufacturing series exclude manufacturing operations in government establishments, such as arsenals and navy yards. "Production and Related workers" include working supervisors and all non supervisory workers. (including group leaders and trainees) engaged in fabricating, processing, assembling, inspection, receiving, storage, handling, packing, warehousing, shipping, maintenance, repair, janitorial and guard services, product development, auxillary production for plant's own use (e.g., power plant), record keeping, and other services closely associated with the above production operations.

"Construction workers" include the following employees: working supervisors, qualified craft workers, mechanic's apprentices, laborers, etc., whether working at the site of construction or in shops or yards at jobs) such as precutting and preassembling) ordinarily performed by members of the construction trades.

"Nonsupervisory employees" (not above the working supervisory

level) include office clerical workers, repairs, salespersons, operators, drivers, physicians, lawyers, accountants, nurses, social workers, research aides, teachers, drafters, photographers, beauticians, musicians, restaurant workers, custodial workers, attendants, line installers and repairers, laborers, janitors, guards, and other employees performing similar services.

A.2. Hours and Earnings

Source: U.S. Dept. of Labor, Bureau of Labor Statistics. The hours and earning series are based on reports of gross payroll and corresponding payed hours for full- and part-time production and related workers, construction workers, or nonsupervisory workers who receive pay for any part of the pay period. Total gross payrolls are before deductions; e.g., for old age and unemployment insurance, group insurance, withholding taxes, bonds, and union dues. The payroll figures also include pay for overtime, holidays, vacations, and sick leave) paid directly by the employer for the period reported). Excluded from the payroll figures are fringe benefits (health and other types of insurance, contributions to retirement, etc., paid by the employer), bonuses (unless earned and paid regularly each pay period), other pay not earned in the pay period reported (for example, retroactive pay), or payment in kind (tips, in the value of free rent, fuel, meals, etc.).

Average weekly hours.

The work week relates to the average hours for which pay was received and differs from standard or scheduled hours. Such factors as unpaid absenteeism, labor turnover, part-time work, and work stoppages cause weekly average hours to be lower than scheduled hours of work for an establishment. Also, group averages reflect changes in the work week for component industries. When the pay period reported is longer than one week the figures are reduced to a weekly basis. Some of the industries in this series are not seasonally adjusted because the seasonal component is small relative to the trend-cycle and/or irregular components and consequently cannot be separated with sufficient precision. Overtime or other premium-paid hours are not converted to straight-time equivalent hours. Weekly man hours of employment are the product of average weekly hours and number of production workers.

Average hourly earnings.

Data are on a "gross" basis; that is, they reflect not only changes in basic hourly and incentive wage rates but also such variable factors as premium pay for overtime and late-shift work, and changes in output of workers paid on an incentive basis. Also, shifts in the volume of employment between relatively high-paid and low-paid work and changes in workers earnings in individual establishments affect the general average of hourly earnings. Averages of hourly earnings should not be confused with wage rates, which represent the rates stipulated for a given unit of work or time, while earnings refer to the actual return to the worker for a stated period of time. The earning series do not represent total labor cost to the employer

owing to the exclusion of irregular bonuses, retroactive items, payments of various welfare benefits, payroll taxes paid by employers, and earnings for those employees not covered under the production worker or nonsupervisory worker definition. Similarly, average weekly earnings are not the amounts available to workers for spending, since they do not reflect such deductions as those for income and social security taxes, etc. "Average wage earnings" are obtained by dividing the reported total production for nonsupervisory worker payroll by the total production or nonsupervisory worker hours.

A.3. Industrial Production

Source: Board of Governors of the Federal Reserve System, Division of Research Statistics. The index measures changes in the physical volume or quantity of output of manufacturing, mining, and electric and gas utilities. It reflects output changes at all stages within manufacturing and mining industries (including intermediate as well as final products). The index is normalized so that its value in 1967 is 100. The index does not cover production on farms, in the construction industry, in transportation, or in various trade and service industries. For those industries, gross domestic product was used except in the case of trade where total retail sales was used. GDP and sales figures were deflated by appropriate industry price indexes.

A.4. User Cost of Capital.

The variable is constructed for each of the twenty six industries using the following formula, based on the work of Christensen and Jorgensen (1969):

$$\text{user cost of capital} = C_{sq} + (1 - \alpha)C_{eq}$$

where α is share of structures in total investment, C_{eq} is user cost of equipment, and C_{st} is user cost of structures. The user cost of equipment is computed in the following way:

$$C_{eq} = Q_e[r + \delta_E - \pi_E]\frac{1 - k - uz + Dkuz}{1 - u}$$

where Q_e is implicit price deflator for investment in non-residential equipment, r is γRCB + $(1 - \gamma)(1/PE)$, γ is the fraction of debt financing, RCB is the average yield on long term corporate bonds, PC is the price to earnings ratio of Standard and Poor's Index of stock prices for the 500 largest industrial firms, δ_E is quarterly real depreciation rate, π_E is expected inflation rate in the price of new equipment, computed as a first order autoregression, u is the effective tax rate on corporate profits, k is the effective rate of investment tax credit, z is the present value of depreciation of equipment, and D is a dummy for years tin which the Long Amendment was in effect (1 for 1962:1 - 1963:4; 0 otherwise).

Similarly, the user cost of structures is computed as follows:

$$C_{st} = Q_s[r + \delta_s - \pi_s]\frac{(1 - ux)}{(1 - u)}$$

where Q_s is the implicit price deflator for investment in non-residential structures, δ_s is the quarterly real depreciation rate for structures, and x is the present value of depreciation of structures.

The values of k and γ were derived from data retrieved from the Statistics of Income--Corporate Tax Returns published by the Internal Revenue Service. In particular, k ≡ (investment credit/cost of property used for investment credit), long term debt ≡ bonds maturing in one year or more, and equity total of all items under the capital account.

APPENDIX B

TABLE B.1
STRUCTURE OF 29 X 29 INPUT/OUTPUT TABLE

Row Number of I/O Table	Industry Name	Industry Name	Commerce Department Industry Number
1	INDAG	Agriculture	1-4
2	INDMI	Mining	5-10
3	INCCC	Construction	11-12
4	IND20	Food and Kindred Products	14
5	IND21	Tobacco Manufacturers	15
6	IND22	Textile Mill Products	16-17
7	IND23	Apparel and Other Textiles	18-19
8	IND24	Lumber and Wood Products	20-21
9	IND25	Furniture and Fixtures	22-23
10	IND26	Paper and Applied Products	24-25
11	IND27	Printing and Publishing	26
12	IND28	Chemical and Allied Products	27-30
13	IND29	Petroleum Industries	31
14	IND30	Rubber and Plastics Products	32
15	IND31	Leather and Leather Products	33-34
16	IND32	Stone, Clay and Glass	35-36
17	IND33	Primary Metals	37-38
18	IND34	Fabricated Metal	39-42
19	IND35	Machinery (exc. Electrical)	43-51
20	IND36	Electrical Machinery	52-58
21	IND37	Transportation Equipment	59-61
22	IND38	Instruments	62-63
23	IND39	Miscellaneous	13,64
24	INDTU	Transportation and Utilities	65-68
25	INDT	Trade (Wholesale and Retail)	69
26	INDFR	Finance and Real Estate	70-71
27	INDS	Services	72-77
28	INDGOV	Government	78
29	INDDUM	Dummy Industry	80-85

TABLE B.1 (cont.)

Commerce Department Industry Number	
1	Livestock and Livestock Products
2	Other Agriculatural Products
3	Forestry and Fishery Products
4	Agricfuture, Forestry and Fishery Services
5	Iron and Ferrolloy Ores Mining
6	Nonferrous Metal Ores Mining
7	Coal Mining
8	Crude Petroleum and Natural Gas
9	Stone and Clay Mining and Quarrying
10	Chemical and Fertilizer Mineral Mining
11	New Construction
12	Maintenance and Repair Construction
13	Ordinance and Accessories
14	Food and Kindred Products
15	Tobacco Manufacturers
16	Broad and Narrow Fabrics, Yarn and Thread Mills
17	Miscellaneous Textile Goods and Floor Coverings
18	Apparel
19	Miscellaneous Fabricated Textile Products
20	Lumber and Wood Products, Except Containers
21	Wooden Containers
22	Household Furniture
23	Other Furniture and Fixtures
24	Paper and Allied Products, Except Containers
25	Paperboard Containers and Boxes
26	Printing and Publishing
27	Chemicals and Selected Chemical Products
28	Plastics and Synthetic Materials
29	Drugs, Cleaning and Toilet Preparations
30	Paints and Allied Products
31	Petroleum Refining and Related Industries
32	Rubber and Miscellaneous Plastics Products
33	Leather Tanning and Industrial Leather Products
34	Footwear and Other Leather Products
35	Glass and Glass Products'
36	Stone and Clay Products
37	Primary Iron and Steel Manufacturing
38	Primary Nonferrous Metal Manufacturing
39	Metal Containers
40	Heating, Plumbing and Structural Metal Products
41	Stampings, Screw Machine Products and Bolts
42	Other Fabricated Metal Products
43	Engines and Turbines

TABLE B.1 (cont.)

Commerce Department Industry Number	
44	Farm Machinery and Equipment
45	Construction, Mining and Oil Field Machinery
46	Materials Handling Machinery and Equipment
47	Matal working Machinery and Equipment
48	Special Industry Machinery and Equipment
49	General Industrial Machinery and Equipment
50	Machine Shop Products
51	Office, Computing and Accounting Machines
52	Service Industry Machines
53	Electric Industrial Equipment and Apparatus
54	Household Appliances
55	Electric Lighting and Wiring Equipment
56	Radio, Television and Communication Equipment
57	Electronic Components and Accessories
58	Miscellaneous Electrical Machinery (Equipment and Supplies)
59	Motor Vehicles and Equipment
60	Aircraft and Parts
61	Other Transportation Equipment
62	Scientific and Controlling Instruments
63	Optical, Ophthalmic and Photographic Equipment
64	Miscellaneous Manufacturing
65	Transportation and Warehousing
66	Communications, Except Radio and TV Broadcasting
67	Radio and TV Broadcasting
68	Electric, Gas, Water and Sanitary Services
69	Wholesale and Retail Trade
70	Finance and Insurance
71	Real Estate and Rental
72	Hotels, Personal and Repair Services Except Auto
73	Business Services
75	Automobile Repair and Services
76	Amusements
77	Medical, Educational Services and Nonprofit Organizations
78	Federal Government Enterprises
79	State and Local Government Enterprises
80	Directly Allocated and Transferred Imports
81	Business Travel, Entertainment and Gifts
82	Office Supplies
83	Scrap, Used and Secondhand Goods
84	Government Industry
85	Rest of the World Industry

TABLE B.2

INPUT/OUTPUT TABLE - MILLIONS OF 1979 DOLLARS

	INDAG	INDMI	INDCC	IND20	IND21	IND22	IND23
INDAG	51235	1	313	71881	1804	2224	199
INDMI	430	6460	2163	130	5	37	8
INDCC	1080	2423	79	432	12	96	43
IND20	10629	9	54	39911	17	91	35
IND21	3	2	18	3	3284	1	3
IND22	353	33	889	32	0	13118	13895
IND23	79	15	59	105	0	135	11232
IND24	240	175	20515	130	8	122	55
IND25	0	0	698	0	0	0	0
IND26	412	87	849	6866	285	434	832
IND27	59	12	64	1282	117	14	77
IND28	10437	881	4187	1836	20	6887	1117
IND29	6210	1127	9038	1228	29	281	252
IND30	822	323	2876	2241	205	525	459
IND31	34	1	6	1	0	0	351
IND32	58	146	22264	3661	7	181	25
IND33	27	842	10433	111	3	16	16
IND34	512	607	32763	8381	55	86	37
IND35	1117	2164	3228	357	16	426	103
IND36	127	312	9537	61	0	14	43
IND37	272	133	110	27	1	2	3
IND38	20	17	797	21	0	50	5
IND39	33	49	484	18	0	8	717
INDTU	4959	2497	6420	8910	370	1960	1592
INDT	6736	1106	24954	10877	296	2081	2547
INDFR	13693	7822	3746	2200	107	586	1111
INDS	3528	2324	16112	9033	936	1253	1942
INDGOV	34	75	99	200	29	49	135
INDDUM	9	269	62	5266	75	364	247
VALUEADD	69867	77677	152054	61399	7282	10069	15273
TOTAL	182947	107789	326871	236580	14667	41110	52354

TABLE B.2 (cont.)

	IND24	IND25	IND26	IND27	IND28	IND29	IND30	IND31
INDAG	5231	6	52	10	205	5	10	0
INDMI	112	14	541	1	3180	88759	115	5
INDCC	142	42	492	205	812	1229	210	12
IND20	6	65	406	28	1506	987	12	528
IND21	2	2	4	9	14	2	3	1
IND22	24	1288	487	77	45	12	1387	539
IND23	27	130	24	35	41	3	36	29
IND24	14607	2866	4364	0	104	11	176	74
IND25	2	162	0	0	0	0	0	0
IND26	187	327	17511	10149	2816	399	1142	155
IND27	9	25	46	5709	262	9	27	5
IND28	773	256	3669	1197	38323	2872	12268	249
IND29	1265	127	1290	257	2489	11832	296	49
IND30	295	1216	936	389	2616	113	2052	611
IND31	7	47	2	10	13	2	4	1460
IND32	471	237	134	66	825	201	288	8
IND33	236	1208	172	185	1067	247	374	26
IND34	1766	1396	320	98	2516	763	551	163
IND35	332	67	420	196	1280	136	545	48
IND36	58	24	5	8	65	8	46	7
IND37	85	3	3	7	3	5	35	0
IND38	19	10	43	399	121	37	51	1
IND39	31	50	27	147	51	9	64	103
INDTU	2024	943	4898	3155	9380	9561	2698	246
INDT	1920	1136	2532	1778	2585	705	1291	359
INDFR	666	515	1207	3425	3761	1176	796	168
INDS	1299	865	2098	5035	12919	1921	1969	314
INDGOV	36	27	104	807	209	81	40	28
INDDUM	21	27	553	30	793	148	931	4
VALUEADD	18389	7308	21919	28579	51880	17167	805	3613
TOTAL	50042	20389	64258	61991	117945	138734	28222	8805

TABLE B.2 (cont.)

	IND32	IND33	IND34	IND35	IND36	IND37	IND38	IND39
INDAG	18	24	40	16	23	15	7	33
INDMI	2845	10583	120	37	64	97	28	42
INDCC	293	1001	277	362	336	126	139	116
IND20	20	18	19	81	66	59	56	62
IND21	5	5	8	21	24	18	5	7
IND22	143	51	21	94	104	652	224	394
IND23	17	42	81	54	79	1706	19	80
IND24	425	620	498	323	328	1551	95	896
IND25	0	35	0	4	668	751	0	0
IND26	1221	234	845	519	1219	376	809	894
IND27	31	82	437	162	339	157	42	27
IND28	1761	3445	1946	578	3198	1452	1501	1311
IND29	694	1199	649	1535	892	945	316	370
IND30	668	423	1212	2102	2883	4518	878	1228
IND31	1	4	1	5	5	7	5	78
IND32	4913	720	633	736	1523	2127	214	178
IND33	400	38871	29139	19064	14922	19462	2656	3290
IND34	380	1764	4674	4706	5366	15944	1016	714
IND35	333	3500	2321	20971	2539	7539	360	321
IND36	90	968	526	7074	23504	7747	1310	586
IND37	10	51	96	639	9	41257	10	771
IND38	39	124	142	170	668	743	1472	71
IND39	71	56	56	157	191	98	173	1277
INDTU	4381	10189	4237	4528	4869	5327	1138	1323
INDT	1222	4686	3202	5517	4933	9760	1180	1266
INDFR	920	1071	1927	4402	3544	1478	768	891
INDS	1619	2985	3335	5780	8310	8068	2418	2522
INDGOV	55	171	90	198	235	225	64	95
INDDUM	242	3176	166	544	720	921	148	944
VALUEADD	21298	56789	45222	66902	50568	68696	15657	14869
TOTAL	44766	143204	101919	147281	132211	201865	32695	34572

TABLE B.2 (cont.)

	INDTU	INDT	INDFR	INDS	INDGOV	INDDUM	TOTAL
INDAG	499	238	1697	3917	48	0	139751.0
INDMI	28969	0	6	91	1458	0	146058.0
INDCC	10120	1882	27720	5677	5645	0	61003.0
IND20	452	231	136	33207	752	0	88567.0
IND21	20	41	41	56	5	0	3607.0
IND22	96	30	0	256	11	0	34255.0
IND23	201	201	72	2190	96	0	16788.0
IND24	18	80	1	184	0	0	48466.0
IND25	0	0	0	0	0	0	2320.0
IND26	430	3917	836	3044	98	0	56893.0
IND27	833	893	3003	3290	224	0	17237.0
IND28	601	285	242	7485	961	0	111141.0
IND29	21862	7880	3439	7166	1566	0	84283.0
IND30	1183	1133	732	3678	77	0	36394.0
IND31	7	27	17	446	5	0	2546.0
IND32	86	157	12	1624	30	0	41525.0
IND33	472	13	3	124	21	0	143400.0
IND34	431	143	37	2724	61	0	88370.0
IND35	1119	236	105	2250	129	0	52158.0
IND36	2798	328	127	4403	142	0	59918.0
IND37	3445	187	69	15224	179	0	62636.0
IND38	154	89	94	4002	28	0	9387.0
IND39	171	194	192	2177	23	0	6627.0
INDTU	80094	22864	10551	27062	7939	0	248061.0
INDT	5714	7372	2376	18022	450	0	127381.0
INDFR	13460	28451	76236	41372	1567	0	217066.0
INDS	22912	45060	29486	58645	2242	0	254930.0
INDGOV	1259	2442	4414	3306	96	0	14603.0
INDDUM	4549	185	284	423	622	0	21723.0
VALUEADD	182757	310444	392320	352317	29837	236994	2387951.0
TOTAL	384710	435003	555148	603780	54912	236994	4561764.0

TABLE B.3

BRIDGE TABLE - MILLIONS OF 1979 DOLLARS

	FPCE	FDGI	PDINV	FDNX	FDGOV	FDST	TOTAL
INDAG	14017	0	7582	19408	-2115	771	39663
INDMI	431	764	1865	-47081	345	56	-43620
INDCC	0	195789	0	58	13164	56396	265407
IND20	142964	0	2587	1663	367	5474	153055
IND21	9041	0	135	1935	0	-3	11108
IND22	4321	1209	504	447	47	158	6686
IND23	41778	0	254	-6085	281	374	36602
IND24	776	9	2326	-1195	51	60	2027
IND25	10206	6822	572	-789	279	1043	18133
IND26	4844	0	1458	-1651	243	1273	6167
IND27	10664	0	894	684	537	4430	17209
IND28	22153	433	2886	10976	2130	3648	42226
IND29	52098	0	6347	-9287	4300	1759	55217
IND30	8453	79	1188	-728	577	565	10134
IND31	9254	0	309	-3636	10	29	5966
IND32	2278	0	1339	-864	58	350	3161
IND33	64	178	5232	-9708	412	21	-3801
IND34	3401	5183	3036	1240	2848	196	15904
IND35	1346	67680	6716	15617	4601	1864	97824
IND36	23858	25964	6903	2196	12606	1466	72993
IND37	53673	56776	5668	-58	18246	2592	136897
IND38	5083	11819	1283	1380	2069	1439	23073
IND39	15273	2179	1530	-1649	7684	1111	26128
INDTU	120763	6343	1852	5644	4925	12285	151812
INDT	270593	22963	2626	7466	2937	3808	310393
INDFR	309370	14018	0	4551	985	10446	339370
INDS	348222	330	202	4287	8338	28632	390011
INDGOV	8722	0	0	227	569	1544	11062
INDDUM	13723	-9763	-51116	18194	81808	165790	218636
TOTAL	1507369	408775	14178	13242	168302	307577	2419443

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